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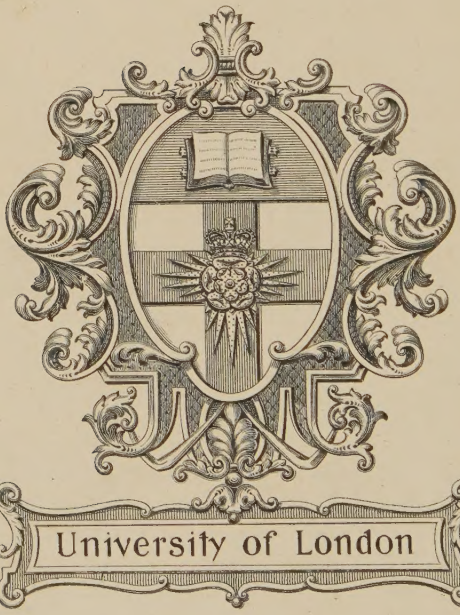


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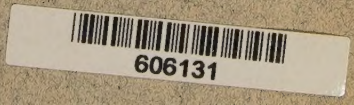
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# REPORTS

FROM

# COMMISSIONERS:

*TWENTY-FOUR VOLUMES.*

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*—(15—PART II.)—*

## PARIS EXHIBITION.

VOLS. III. and IV.

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Session

19 *November* 1867 —— 31 *July* 1868.

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VOL. XXX.—PART II.

# REPORTS FROM COMMISSIONERS:

1867-8.

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*TWENTY-FOUR VOLUMES:—CONTENTS OF THE*

FIFTEENTH VOLUME.—PART II.

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N. B.—*THE* Figures *at the* beginning of the line, *correspond with the* N° *at the foot of each* Report; *and the* Figures *at the* end of the line, *refer to the* MS. Paging

## PARIS EXHIBITION:

[3968-II.] VOL. III. REPORTS on COTTON, WOOLLEN, WORSTED, SILK, and other FABRICS; CLOTHING, and SMALL WARE MANUFACTURES; EDUCATIONAL APPLIANCES; DWELLINGS for the POOR, &c. - - - - - - - - - - p. 1

[3968-III.] VOL. IV. REPORTS on HEATING and LIGHTING; WAR MATERIALS, &c.; MINING; MACHINERY; RAILWAY APPARATUS; TELEGRAPHY; CIVIL ENGINEERING; NAVIGATION and LIGHTHOUSES - - - - - - - - - 341

# REPORTS

ON THE

# PARIS UNIVERSAL EXHIBITION, 1867.

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## VOL. III.

CONTAINING REPORTS ON

COTTON, WOOLLEN, WORSTED, SILK, AND OTHER FABRICS.

CLOTHING AND SMALL WARE MANUFACTURES.

EDUCATIONAL APPLIANCES; DWELLINGS FOR THE POOR, CONSTRUCTED ON SANITARY PRINCIPLES AND AT SMALL COST, AND ARTICLES EXHIBITED WITH THE SPECIAL OBJECT OF IMPROVING THE PHYSICAL AND MORAL CONDITION OF THE PEOPLE.

*Presented to both Houses of Parliament by Command of Her Majesty.*

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FOR HER MAJESTY'S STATIONERY OFFICE.

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# INTRODUCTION.

THE following Reports on the various Classes in the Paris Exhibition, 1867, were prepared for the Science and Art Department in accordance with the directions of the Lords of the Committee of Council on Education, and must not be confounded with the International Jury Reports to be issued by the French Government, which are quite distinct.

The scope and object of these Reports will be gathered from the following extracts from the letter to the gentlemen who were requested to prepare them, and who in many cases were not connected with the International Jury:—

"The Lord President of the Council, following the precedent of the Paris Exhibition of 1855, is desirous of obtaining a series of Reports on the objects exhibited in the Paris Exhibition of this year. . . ."

"The special object of this Report is to direct the attention of British visitors, manufacturers, and others, to the useful novelties exhibited by various nations on the present occasion, to which it appears desirable their attention should be called. It is not intended to be an exhaustive Report upon the class, which it is presumed will be made by the International Juries for the Imperial Commission. The British Report should have special reference to the objects exhibited by the British Colonies and by Foreign countries, rather than those exhibited by the United Kingdom, although the latter should not be overlooked."

"It is desirable that the Report should be as short as may be consistent with the nature of the subject, and it is absolutely necessary that it should be published during the Exhibition. It will therefore be indispensable that if the Report be undertaken by you, the manuscript should be delivered before the 15th of June at latest, and as much earlier as may be possible, to Captain Donnelly, R.E., the Secretary to the British Juries, who will afford all necessary information in Paris, and will act as Editor to the Reports."

"It is probable that the Exhibition will be sufficiently arranged to enable an examination of the Class to be commenced about the 15th April."

With the view of rendering these Reports useful to the public while the Exhibition lasted it was determined to publish them in a newspaper as quickly as possible. Arrangements having been made with the manager of the *Illustrated London News*, who undertook to produce them free of all cost to the Science and Art Department with a certain amount of illustration, the publication commenced on the 6th July 1867, and continued till the 7th December. By that time about two-thirds of the Reports had been published. These have been revised by the authors, and with the unpublished ones are complete in these volumes.

In arranging the Reports the order of the French classification has not been implicitly followed. The amount of matter rendering the division into four volumes desirable, those Reports were brought together in each volume which appeared most allied to one another, an arrangement dictated as much by what seemed likely to be to the convenience of purchasers of single volumes as by any idea of a scientific classification.

# REPORTS.

## Report for the Manchester Chamber of Commerce on Cotton Goods.—(Class 27.)—By J. O. Murray, Esq., Paris.

Mr. Murray on Cotton Goods.

Before entering on the detailed review of cotton goods in the French Exhibition, which is the special subject of this Report and which must be mainly interesting as comparing our own with foreign, especially with French cotton manufactures, it may be well to understand a little more of the mutual commercial relations between France and England than is usually known, and to look a little carefully into the results of the Treaty of which we have had now, in six years, time and data to form a judgment. When Cobden undertook that great work there were no very distinct data on which to go. An exaggerated and almost lunatic conception of the outrageous cheapness of English goods prevailed in France, and was appealed to and taken advantage of by the French monopolist manufacturers. Among English merchants and manufacturers an almost equally crazy if somewhat less exaggerated idea prevailed that, if duties similar to and if possible less than those in the States could be obtained, an immense market would open at their doors. The latter forgot that the French, though living under a system of strict prohibition of English goods generally, yet managed to be quite sufficiently clad and housed with their own manufactures—in this totally unlike the States, Italy, Spain, &c. The former, in their excited selfishness, shut their eyes to all facts and reasons, and blindly shouted for heavy duties. I don't think the only simple and business-like data on which a correct judgment could have been formed in regard to the real position, an independent and correctly priced sampling of the manufactures of both countries, was ever properly made and authoritatively appealed to; or the wild alarms of the French and the quiet confidence of the English would have been considerably modified, and more reasonable duties, at all events as regards cottons, would have been provided for ere this date in the Treaty. My own impression, on pricing French calicoes, six months before the treaty, was that certain classes were actually cheaper than similar descriptions by our first and largest

Results of the French Commercial Treaty.

Mr. Murray on Cotton Goods.

makers; and on sending over a few hundred pieces of greys to Manchester, they, to the surprise of every one in the trade, sold readily at a profit, and were the precursors of the large importations of French calicoes which have followed since.

Amid our annual flourishes of trumpets over the increasing greatness of our French trade, we seldom look even roughly into its component elements and their relative importance. I will take some figures on the subject from French government statistics, as they give the actual consumption of our imports, and the export of their own products and manufactures; whereas our Board of Trade tables give, as exported to France, all that is shipped for French ports, much of which is only in transit for Germany, Switzerland, and Spain; and as imports from France much which, though coming from French ports, is not of French origin at all. In 1865 (the tables for 1866 are not yet out), the total imports into France from England were 29½ millions, of which 25½ went into consumption; the exports from France into England were 53 millions, of which over 40 were French products and manufactures. We see, then, which of the two countries is the greatest producer and exporter; and an analysis of the relative amounts will still further show how differently from what was expected the Treaty has developed trade. Of the 25½ millions of English imports no less than 18 are raw materials (⅞ foreign produce, ⅛ coal) paying an average duty of ⅛ per cent., except coal which pays 5½ per cent.; four millions are half raw materials, of which over a quarter is yarn, paying 5½ per cent. duty, and nearly half colonial produce, paying 30 per cent. duty, except cigars (a government monopoly), the duty on which is 1½ per cent.; and of the 25½ millions sterling not 3 millions are British manufactures, which paid an average duty of 10 per cent. from 27½ per cent. on potteries and glass, 20 on cutlery, 16 on timber, 13 on cottons, to 7½ on metal works, and 1 per cent. on silks. But of the 40 millions sterling of French products imported into England, 6 only are raw materials and 12 half raw, all home produce, while no less than 21 millions are manufactures imported duty free, against the 3 millions of ours, admitted grudgingly into France under heavy duties. And not only is there this great disparity in the amounts of manufactures exchanged, but all the rest of the French exports are French products, while nearly all the rest of ours are foreign or colonial produce. That is, while nearly all our exports to France are the results of foreign labour

on which we have merely the profits of an exchange, raw materials which our industry has not touched further than is involved in transport and bill broking, their exports to us are nearly all, 40 millions out of 53, the results of home labour, the products of French industry, whose successive profits in each successive operation are entirely concentrated in French hands.

Now, without enlarging on this great disparity of positions or thinking for a moment of reversing or narrowing that free-trade policy which we have recognised as logically just, and which in this case enables France to send us in 21 millions of her manufactures while she shuts out all but 3 millions of ours, I think we may at least say that the position thus revealed by the figures of the French government itself, as made to French industry by the Treaty of Commerce, is not one which can be honourably maintained, at all events towards us. The plea that French industry could not stand before ours without a strong protection is utterly falsified by the facts. An industry which exports 21,000,000*l.*, against 3,000,000*l.* imported, is not in the delicate and imperfect position so loudly pretended by the protectionist manufacturers. To continue to import into our markets without duty, and without even a prejudice, and yet to shut out our cottons by duties of 10, 20, and 30 per cent., which are prohibitions rather than duties, would be to take a mean and unmanly advantage of our adoption of a large and noble principle. Whatever the unlimited selfishness of the monopolist leaders may be shameless enough to utter, the nation and the government cannot honourably continue such duties, so purely inimical and so evidently unnecessary. Besides, the cotton duties have remained, since the beginning of the treaty, unchanged, while those on woollen cloths, Bradford goods, carpets, &c., have been reduced from 15 to 10 per cent., a reduction which has, in some of these goods, served to maintain, with great difficulty, a comparatively feeble trade; and the absence of which reduction, as regards cotton, maintains an almost absolute prohibition.

Details of imports and exports under the French Treaty.

But we will not content ourselves with the merely general figures quoted above—we will analyse these totals, at least, as far as regards textile manufactures, and see the details of each sort imported and exported. These I give in French figures, that is in millions of francs, since, as regards the small import of manufactures, we cannot descend into details, if we maintain as a unit of calculation that pleasant round sum, a million of pounds.

Mr. Mueray on Cotton Goods.

LEADING MANUFACTURES EXPORTED FROM FRANCE TO ALL PARTS, NATIONAL PRODUCTS ONLY.

| —— | 1860. | 1861. | 1862. | 1863. | 1864. | 1865. |
|---|---|---|---|---|---|---|
| Silks - - - | 454·8 | 333·3 | 363·5 | 370·3 | 408·2 | 428·5 |
| Woollens - - | 229·3 | 188·0 | 221·7 | 293·6 | 355·9 | 302·8 |
| Cottons - - | 69·6 | 56·4 | 63·3 | 88·2 | 93·7 | 93·5 |
| Linens - - - | 15·4 | 14·9 | 14·7 | 19·0 | 24·5 | 25·2 |
| Yarns—Cot., wool. lin. | 12·6 | 9·2 | 17·3 | 43·7 | 43·1 | 35·4 |
| Dresses, mercery, umbrellas, furniture, all more or less the above manufactures made up. | 202·0 | 172·7 | 235.3 | 242·0 | 305·2 | 326·0 |
| | 983·7 | 774·5 | 915·8 | 1056·8 | 1230·6 | 1211·4 |

LEADING MANUFACTURES IMPORTED INTO FRANCE FROM ALL PARTS FOR HOME CONSUMPTION.

| —— | 1860. | 1861. | 1862. | 1863. | 1864. | 1865. |
|---|---|---|---|---|---|---|
| Silks - - - | 3·9 | 4·1 | 4·5 | 4·6 | 7·1 | 11·2 |
| Woollen and wor. threads. | 7·4 | 26·5 | 47·7 | 39·2 | 37·7 | 43·5 |
| Cottons - - | 0·8 | 9·4 | 14·3 | 8·7 | 9·5 | 10·5 |
| Linens - - - | 11·6 | 13·9 | 13·5 | 12·5 | 14·3 | 13·4 |
| Yarns—Cot., wool. lin. | 4·7 | 11·6 | 26·0 | 25·5 | 23·9 | 34·2 |
| Dresses, mercery, &c. nil, or nearly so. | — | — | — | — | — | — |
| | 28·4 | 65·5 | 106·0 | 90·5 | 92·5 | 112·8 |

In order to show the effect of the treaty, I have begun with the year previous to its coming into force, but a good deal of the small imports of 1860 is already due to it. The insignificance of the imports as compared to the exports is remarkable, the total imports being only a tenth part of the exports. Of these exports the great bulk always comes to England, and the rest goes to markets in which they compete successfully with our goods. Even in cotton goods there is hardly an article of which the French do not send us in much more than they take. In gray and bleached calicoes, while they take from us for 19 millions of francs,

they send us in for nearly 22 millions; in prints they take 620,000 francs, and send us for 3 millions; in dyed goods they take 160,000 francs, and send us for over 1 million; in muslins they take 350,000, and send us over 1 million; in hosiery they take 57,000, and send for half a million; and so with several other smaller articles. And yet, while sending these comparatively large quantities into our markets, without duty and without question, they still maintain against our goods heavy inimical duties and all the force of strongly prejudiced opinions. Surely these facts entirely confute the false impressions on which the French government, influenced by the selfish fears of the manufacturers, was induced to impose these almost prohibitive duties; and though the manufacturers will no doubt be as selfish as ever, and will repeat as boldly as ever the old protectionist fallacies, the irrefragable evidence of facts has made a new position, on which the government may safely take its stand for a change of duties more in accordance with the entire freedom and friendliness exhibited on our side.

## France.

France. The splendid display of the French cotton trades takes the lead in this class, and in fulness of representation and excellence of arrangement, is a great contrast with the British display. The simple, united, and effective mode in which each branch, and the whole trade together, is arranged in a succession of six large connected courts, all open so that a general impressive view may be had of all, and yet each distinct and marked by its own character, cannot fail to produce on hundreds of thousands of visitors from all lands a conviction that they see before them the great producing centre of the world, beside which our English exhibition sinks into insignificance. There is no branch absent, and if the plain goods want perhaps in general attractiveness, the splendour of large portions of the dress and furniture draws the attention and admiration of crowds. In place of our 30 exhibitors, there are here 210, besides two general district exhibitions, and a dozen exhibitors under Algeria. It is impossible, therefore, to go into detail, and a few general discriminations must suffice. If we begin with the Rouen Court, in which the heavy yarn and calico trades are represented, and take with it the Alsace Court alongside, where the lighter calicoes are shown, it will be noticed that in their yarns and in their grey calicoes the French makers still employ, for similar numbers

Mr. Murray on Cotton Goods.

and weights, more superior cotton and less low cotton or waste than we do, and give their yarns more twist, thus reducing the production, and in this respect, as well as in cost of raw material, enhancing the cost of the manufactured article. Among the 80 exhibitors of yarns, representing the 6,250,000 spindles of the French cotton trade, we have some, in low numbers especially, whose samples closely resemble our ordinary makes; but the average is cleaner, harder, and finer in material. This produces a cloth generally in all weights harder in feel, purer in appearance, and, doubtless, in so far superior to similar counts and weights of English make. Indeed, there are some grey calicoes, representing makes of shirtings and linings generally sold, and military-contract cloths (with a blue line up the piece), so fine in material, even when heavy in style, that we have nothing in current production to match them. In regard to price, so far as I have been able to obtain prices and make comparisons, there does not seem to be more difference than would be accounted for by this difference in material and make. The French market, doubtless, demands this superior article, or the French manufacturer would not continue to make on this system; but it seems as unnecessary as it is dog-in-the-manger-like to shut out by heavy duties the inferior article from such consumption as it might find, in order to maintain a style of make from which the French manufacturers seem indisposed to change. The superior article would, doubtless, find, as it seems to have found since the Treaty called the attention of English merchants to it, an increasing demand abroad to balance any diminution of consumption at home. For, now that the French manufacturers, whose attention and ambition were excited by the English superiority in 1855, have laid down new machinery, with all the modern improvements in almost every mill in France, the difference of position is almost abolished, and their 200,000 to 300,000 looms can produce almost, if not entirely, as well and as cheaply as ours. Indeed, while exporting nearly 38,000,000f. worth of their own calicoes, they do not take 2,000,000f. of foreign calico; showing, surely, a strong enough position. The French bleached calico still appears almost universally with a hard, gritty finish, which is partly in the nature of the cloth and partly in the nature of the finish, as may be remarked in the samples of their leading bleachers, Gros Roman and Co., Metzdorff and Davillier; and the market seems to prefer this to any variety of ours, though some improvements in it are noticeable of late years, and one of these bleachers shows several attempts at varied finishes,

Superiority of French yarns.

still far behind ours. The two principal dyers, Cronier, of Rouen, and Haeffely, of Mulhouse, show very interesting and skilful sets of sample pieces. In some small details of treatment, as in making up, they are behind us; in varieties of finish they do not need to come up to us; but in the styles of work, either dyeing, printing, or finishing, required by their market, they turn out as well and quite as cheaply as we can, and have no real need of the heavy protection they have established against us of nearly $1\frac{1}{2}d.$ on the pound of English dyed cloth, in addition to the duty on the undyed cloth. Indeed, so little need have they of protection, that one of them, who gets through 600,000 pieces a year, I am told, is yet so unable to cope with his work that he keeps regularly three months' work before him—a singular inconvenience to merchants in times of such irregularity of prices. I may also add that, while the customs acknowledge for 241,600f. of dyed cottons imported, they give the exports at 14,000,000f. more; so that the imports are a mere inconsiderable fraction; and this does not include the yarns and cloths exported after free admission for dyeing. In printed calicoes and muslins it is hardly necessary to quote statistics in order to show an equality in many respects and a superiority in some, which all the skill of our great printers cannot dispute. That there should be for only 22 millions of francs exported (against less than one million imported), only shows the baneful influence of protection, the material on which they work being protected by a heavy duty, which hinders the extension of their foreign trade. It is true they are allowed to receive free of duty, to print in bond, three millions worth of foreign cottons, which they re-export worth four millions and a half; but this is a lame and round-about way of doing a foreign trade. And yet the most liberal and one of the most considerable of the French printers, M. Jean Dollfus, who ranks himself among freetraders, would fain have had the Treaty give his trade a protection equal to a doubling of the duty on grey calicoes. Surely, no one can imagine that the magnificent displays in the Rouen and Mulhouse courts really require any such crutches to sustain them. In the heavier prints, for the use of the million, shown in the Rouen court, there is much resemblance, of course, to the great productions of the Manchester district. Putting aside a noticeable difference of tone in the colours and a preference of blue whites to clear whites, demanded by the taste of their market, there is nothing in the work of the Rouen printers to distinguish it from similar work in Lancashire. Some styles there may be which have not yet

Dyed fabrics.

Printed calicoes and muslins.

Heavier prints.

Mr. Murray on Cotton Goods.

reached us, and some clever applications of practical ingenuity in individual instances, which Manchester printers will quickly distinguish; but similar things would have been remarkable in the work of the English printers had it been exhibited. The muslins and lighter prints, however, in the Mulhouse court decidedly surpass in splendour anything England produces. I do not say could produce, if it suited English printers to determine to do so. And yet I doubt much if it lies sufficiently in our modes of thought to produce these gay and fanciful and changeful elegancies. In any case, the large cost and the small return, the difficulty and uncertainty and risk, would rise before the eyes of the English printer, shutting out their beauty and their richness, and sadly disturbing his pride in their splendid work and artistic style. But no such doubts hold the hands of the Koechlins, Thierry-Miegs, Dollfus-Miegs, Schlumbergers, Steinbach Koechlins, Gros Romans, and others, whose dazzling displays of printed muslins, reps, muslins de laine, and other tissues, in dresses, furnitures, and shawls, seem to concentrate all the taste and talent and disregard of cost which the most spendthrift humours of imperial Babylon could desire. The colours may be pigment, artificial, unsolid, evanescent; but the general effect is rich and elegant, and charming. And who among the light and easy class which will wear them looks beyond these superficial but all-sufficient graces, or thinks of counting costs of production in relation to extent of sales? This wonderful display, unsurpassable in its kind, does great honour to the enterprise of the French printers in the direction of *hautes nouveautés*. Crossing to the Tarare court, we find ourselves among a display almost as magnificent of embroidered curtains, of white and coloured muslins (plain and embroidered), of grenadines and tarlatans, gauzes and tulles. The well-managed effects in the curtains of various muslins worked on the tulle foundation among the embroidery, the bold and soft contrasts, the skilful and elegant designs, are well exemplified in Mr. Ruffier Leutner's display, and carried even to excess in Messrs. Meunier's remarkable pieces. The defect of the display in this court generally is that the articles shown are mostly got up expensively and especially for exhibition, and the ordinary articles of current sale are hardly represented. And yet with all their effort and all their protection the Tarare makers are quite equalled if not surpassed by the unprotected Swiss. In the excellent show of plain muslins there is no sign of a trade lagging behind or needing protection from superior energies abroad.

Superiority of French muslins and lighter prints.

The next court, that of St. Quentin, cannot be said, in its mousselines brochées nor in its guipures, to be equal to Glasgow and Nottingham, nor, in its quiltings, to be quite equal to Manchester; but in neither the first nor the last article is it far from parity. In quiltings decided progress has been made since 1855. The next court—that of Flers and Roanne, opposite the Rouen court—completes the French cotton display, and contains articles in many respects peculiarly French, the blouse cloths so largely worn by the working classes and the toiles de Vichy. What is remarkable in the blouse is its excellence of material and of make, and it is a pity that the dye is not better and faster. We have no cotton stuff for the million at all resembling it in real goodness of quality. A stuff for the million with us somehow goes down rapidly in price and quality to a mere mockery and sham; but the million in France is not to be deluded into such false economy. These coutils for shirts, trousers, and blouses, as well as those for stays and mattresses, of which a full and varied assortment is here laid out, have an industrial centre of their own at Flers, in Normandy, where three hundred manufacturers employ some 14,000 looms and 28,000 hands in the production of 200,000 to 250,000 pieces annually, of the value of 25,000,000f. to 30,000,000f. The prices in 48 in. vary from 8*d.* to 2*s.* 6*d.* a yard. The toiles de Vichy, whose centre is Roanne, in the middle of France, are a sort of gingham, but as superior for women's wear to our nearly extinct and always miserable gingham as the blouse-cloth for men's wear is to its nearest similar with us, the cotton stripe and check. The fustian trade, to judge by the only two exhibitors, does not seem to be as flourishing as these other branches. One exhibitor, from Amiens, professing to make from patriotic motives, evidently expects the consumer's patriotism to shut his eyes to the mediocrity of the stuff exhibited; and another from Ourscamp, Oise, shows a very fair and well-made article, but would probably appeal to patriotism also in regard to price. In fact, velveteens, moles, and cords, as working-class costume, do not accord with the national habits, firmly and universally fixed as they are in favour of the blouse cloth; so that fustians have but a partial and unimportant consumption, and no great impulse is given to their production, beyond a sort of greedy little jealousy to make, and be protected, that is, subsidised in making, whatever English makers produce. Among the exhibitions in the Rouen court is one of coloured cotton reps for furnitures, in lively coloured stripes of good effect, which

Blouse cloths.

Toiles de Vichy.

Fustian.

Coloured cotton reps.

Mr. Murray on Cotton Goods.

is an article unattempted, I think, in England, and yet one of sufficient consumption in warm countries to merit some attention.

## United Kingdom.

Great Britain.

The exhibition of British cotton goods is chiefly remarkable, as to its contents, for the absence of many important or essential departments, and, as to its arrangement, for the absence of the practical common sense one is accustomed to expect in connection with that large and active manufacture. The Cotton court should have been arranged upon a simple and systematic plan, by which those products requiring to be hung would be draped against its sides or outer walls, while those most fitly shown in pieces, on tables, would occupy the centre of the court, thus leaving it open throughout to the eye, with an impressive effect and a distinct relationship of parts. In place of this we have an entire absence of any general constructive idea and a dominance of mere individualisms, each stretching as high and as wide as possible, without regard to his neighbour, or even to any special suitability to his own requirements. Thus we have a trade display without any unity beyond what is involved in mere juxtaposition, and without proper effect as a whole. The quilts, which occupy a large space, and would have hung well around the court, with the dimities, figured furnitures, and coloured stuffs, are hung in the middle, obstructing the view, and not sufficiently seen themselves; while white calicoes, tapes, yarns, and other quite unsuitable articles form the walls of the court—though, in fact, there is no court at all, but a muddle of cases of all sorts, heights, and shapes, without any attempt at plan or classification. To make matters worse, all the cases are glazed—the refraction and reflections of the glass rendering it often impossible to see the goods, and the glass preventing all examination by touch. It seems hardly comprehensible that practical business men should incur trouble and expense to send their goods so far, in order to shut them up from the examination they were sent to invite. As for any damage they might receive from dust or fingering, it would cost less to re-bleach them than to case them in glass. As it is, the greater part of the British cotton display is mute and useless to a practical visitor, and quite unattractive to the general public. It is not so in the French calico courts, where all the goods are entirely open—the whitest calicoes and the finest muslins—and where unity of arrangement has been firmly and effec-

Arrangement of the Cotton court.

tively carried out. It was not so when Manchester last exhibited in Paris, in 1855, when pieces of all sorts lay open on the tables, and when a calico court, simply but systematically arranged, showed that plain goods *could* be made to attract a large share of public interest, notwithstanding preconceived ideas of some authorities who had thought otherwise.

Incompleteness of the exhibition.

The absences which are remarkable include, unfortunately, most of the leading branches of the trade; and it would be impossible to make any discriminating remarks on this class without referring to them. The Scotch manufacturers entirely abstain, and thus several of the lighter branches of the trade are quite unrepresented. There are no plain or printed muslins, no embroidered muslins, no Jacquard muslin curtains, no muslin linings, no ginghams, no handkerchiefs; and we are thus deprived of means of comparison with many of the products of Mulhouse, of St. Quentin, and Tarare, as well as of Switzerland, Belgium, and Prussia. Even from Manchester, whence the only exhibitors come, most of the leading branches have failed to appear. Yarns, with one exception, are conspicuously absent; not only is there no complete range of numbers and sorts, but this immense article of production, of which we export over 10,000,000*l.* worth in the year, is as completely unrepresented as if we did not know it. The still more important article of calico, of which we export for 23,000,000*l.*, is, except in one branch—best-class shirtings, which is triply or quadruply represented — equally absent and ignored. Another immense branch, that of prints, which spreads for more than 16,000,000*l.* of its products over the world, has also refrained from appearing. Except the article of sewing-thread, which is well represented, of which we export for 750,000*l.* sterling, and the one branch of calicoes just mentioned, the Manchester exhibition consists of a few minor branches—in most cases imperfectly represented—which do not sum up altogether a million in our exports.*

This remarkable absence—remarkable especially when compared with the crowds of exhibitors in the French and other cotton industries—is the result partly of a general indifference to exhibitions as business speculations, and partly of a special indifference to exhibiting in a market which sends into England, without a shadow of duties, 21,000,000*l.* of French manufactures, while shutting out by a

* These statistics are taken from the Board of Trade Reports for 1865, the last published; and those in relation to French goods from the French Customs Reports for the same year.

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hostile tariff, erroneously called a free trade treaty, all but 3,000,000*l.* of British manufactures.

Yarns.

In yarns, as already mentioned, there is no consecutive display. A single and remarkable example of fine numbers, from 160 to 410, is shown by Messrs. Henry Bazley and Co., Ancoats; but of common and coarse numbers there are no specimens at all, one or two fancy sorts alone appearing; samples for union woollens, by Mr. J. M. Johnson, Mirfield; and dyed samples by Messrs. J. Townshend and Son, of Coventry. But of sewing cottons we have half a dozen remarkable displays—Messrs. J. Brook and Brothers, of Huddersfield; Walter Evans and Co., of Derby; Clark and Co., and J. and P. Coates, of Paisley; E. Ashworth and Son, Dickens and Co., and J. and E. Waters, of Manchester, all exhibit carefully-arranged assortments, the case of the last-mentioned house being a large and elaborate imitation of the Albert monument in Manchester, and one of the leading attractions in the vestibule of the Exhibition. In grey and bleached calicoes we have a single example of first-class heavy shirtings and sheetings in a range shown by Messrs. S. Radcliffe and Sons; and three full representations of bleached shirtings of the best and finest sorts by Messrs. Crewdson and Worthington; Horrockses, Miller, and Co; and J. Hawkins and Son. These I have no doubt maintain the wide and well-founded reputations of those houses; but, being under glass, and in many cases so placed that no details whatever of the cloths can be seen, while no examination can be made of their peculiarities in finish, in feel, and in structure, the drapers, shirtmakers, or wholesale dealers who might have been led to try and to adopt some of the sorts in their trades, are precluded from making any acquaintance with them. The most prominent and attractive displays in the Manchester cotton space are the quilt and quilting cases. Messrs. Barlow and Jones have made, perhaps, a mistake in composing the principal part of their exhibition with quilts, evidently made expressly for show, and of too costly a sort for large or general sale; while Messrs. Johnson and Fildes have evidently taken fair ordinary specimens of current sale from their usual production; but both displays are good, and highly creditable, and in quiltings also, of which they show a varied and excellent assortment, maintain a position which is quite unequalled in the French, Belgian, German, or other exhibitions. The styles of pattern in the quilts—neat grounds, and symmetrical objects, well balanced, and contrasting well with the grounds and with each other—are a decided progress from the sprawling, ill-concerted, and ineffective

Sewing cottons.

Calicoes.

styles prevailing some years ago, and seem, besides, to work up much better in the cloth. Of this article we export over 50,000*l.* Some well executed bed quilts are also shown by Messrs. W. M. Christy and Son in terry patterns; but the most important part of their display is their well-known towels and bath cloths, in cotton and linen terry; a make, the original of which may be seen in the Turkish kiosk, in the park, and in the Ottoman exhibition, in many beautiful samples of similar towels, as well as in hangings and couch coverings. In this article Messrs. W. H. Glover and Co. also make a varied and successful show. In fustians, a large branch which exports over a quarter of a million sterling, we have no ranges of the commoner sorts, but of the better sorts we have a few excellent examples. Messrs. Kesselmeyer and Mellodew show admirable specimens (under glass unfortunately) of that superior make and silk-looking finish, by the introduction of which some dozen years ago they raised the character of cotton velvets and velveteens, and astonished those most familiar with the manufacture. Messrs. Langworthy also show what, as far as can be judged through glass, are equally remarkable specimens of similar goods, accompanied by a beautiful range of cords of different sizes, and by a first-rate collection of cotton drills, making altogether one of the most noteworthy displays in this class in the exhibition. The equally important and interesting exhibition of Sir E. Armitage and Sons, consisting of sail-cloths, tent-cloths, and other heavy cottons, as well as light negro trouserings, &c., would also attract deserved attention more largely if they were not shut in from examination. The large article of home and foreign trade, checks and stripes for shirtings and trouserings, is otherwise quite unrepresented. The dimities and figured furniture cottons of Messrs. Martin and Johnson are interesting, but do not seem to be different from what they have been for many years back. The great branch of prints, as I have said, is completely absent. And another important branch in which, I think, we equal and excel all competitors—dyed cottons—is also almost entirely absent. One department, most successfully pursued by several Scotch and English dyers, that of beetled imitation-silk finish, is well represented by Messrs. Barlow. Their specimens are invariably taken at first for silk, even by practical cotton merchants, and deserve decidedly favourable remark. An important branch of production, which besides extensive consumption at home supplies 320,000*l.* worth abroad, that of small wares, is but slightly represented by Messrs. Waters in the base of their fine specimen of bobbin-architecture; and by Messrs. Cash, of Coventry, who show cotton frillings and edgings.

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Fustians.

Mr. Murray on Cotton Goods.

Continuing our tour onwards beyond the English exhibition, we may trace out the cotton manufactures of the other countries in their order as they follow each other along the Galerie de Vêtements. India has but a small display in Class 27, but interesting as far as it goes—coloured striped tablecovers, and furniture stuffs in cotton reps, damasks, fancy towels, bedcovers, calicoes, fine spot and stripe muslins, and muslins embroidered in cotton, gold, silver, and beetle wings, from Agra central prison, and from Bengal and Bombay. The other hand-made goods also exhibited by Malta, close by; and, a little further on, by the Central and South American Republics; and in the machine gallery by Brazil, consist chiefly of coarse but strong stripes and checks, ginghams and calicoes for native wear; the checks are open and thin, as required by the climate; coarse, and with less appearance than our power-loom similars; more roughly made, but more genuine and better wear. If, as I am told, there is a desire in Manchester to bring machine-made goods as near as possible to hand-made in their peculiar qualities, these specimens deserve attention as including good examples of articles of large consumption, made in native looms to suit exactly local requirements. There are among them also samples of nankins, capital calicoes in the natural light brown of this sort of cotton, a shade which has been fashionable lately, and is thus much better obtained than by any dyeing, and which constitutes an article that our cotton trade might do well to take up a little, though possibly our power-looms might not turn it out so well.

India

and other countries.

## United States.

United States.

The United States have not sent any contributions to this class, except a case from the Clark Thread Company, similar in contents to that of Messrs. Clark, of Paisley.

## Turkey.

Turkey.

In Turkey we have, in the catalogue, the extraordinary number of 203 exhibitors of cotton goods, but, except a few specimens of yarns, I do not find any evidence of their existence. A good many nicely-made and fringed terry towels, the originals of the productions of Messrs. Christy and Glover in Manchester, are shown in another class. But I have looked in vain several times for the shirtings, sheetings, sail and tent cloths, aladjas, tenfis, abanis, manissas &c. temptingly announced, and promising to gratify a natural curiosity concerning the peculiar taste and habits in regard to cotton goods of the varied tribes of the Ottoman empire. Let us hope they will yet appear, with the

additions which are being still daily and slowly produced in many parts of this immense Exhibition. Egypt and Tunis are equally insignificant in this class—a few bits of plain and dyed calicoes are shown; the colours, when on separate scraps, looking very dirty and dull, products of the simplest and most aboriginal dyeing; but when combined and contrasted they come up much more richly and agreeably. Greece also shows nothing remarkable: a few coarse yarns, cotton plush, and stripes and checks.

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Egypt and Tunis.

Greece.

### PERSIA.

Persia, which is not mentioned in the catalogue, has lately opened out a rich display of goods, among which are printed cotton furnitures of excellent styles, simple and quiet, but rich and novel. There is much to be learned among these Oriental designs, the growth of the traditional talents of ages.

Persia.

### ROUMANIA.

Roumania, also not in the catalogue, sends a few specimens of hand-made cottons, in dresses and furnitures; a mixed stripe of plush and coloured reps on a couch is worth noting.

Roumania.

### ITALY.

Italy has forty-seven exhibitors, chiefly in the Italian annexe in the park, who show calicoes machine-made, though more like hand-made than the French and English domestics and printers usually; ginghams, stripes and checks, and blouse cloths, having the solid qualities of the French similars; heavy quiltings and fancy cottons, coarse but stout and genuine; well-made reps for furniture; Turkey-red yarns and cloths, all evidencing considerable activity and enterprize.

Italy.

### RUSSIA.

Russia has twenty-one exhibitors (chiefly printers) of whom it may be said that the displays of Zindel, of Hubner, of Konschine, of Zimine, and other Moscow printers, are as good in styles and execution, both in ordinary and in Turkey-red work, as any in the Exhibition, and are really very varied and extensive; while the calicoes and fancy cottons, and stripes and checks are evidently fair and good work.

Russia.

### SWEDEN AND NORWAY.

Even Sweden and Norway take very fair positions. The Rosenlund Mill (E. D. Lundstroem) shows yarns, from No. 2 to 100, as well as calicoes, dyed goods, and sail-cloths;

Sweden and Norway

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Ch. Hill, E. W. Bley, and others show calicoes as fine in material as the French; several other spinners show very good grey, bleached, and dyed yarns; and the Nydalen Company, at Christiana, make a fair display of yarns, twines, calicoes, sail-cloths, and checks.

## Spain and Portugal.

Portugal.

Portugal shows nothing remarkable. There are eight exhibitors of common prints, calicoes, dyed goods, bedticks, raised twills, stripes—evidently a small and not advanced

Spain.

trade. But Spain, with fourteen exhibitors, makes a considerable and decidedly creditable display, showing that, whatever may be the decadence of the country generally, there is spirit and energy at Barcelona. Ferrer, Achon, Paul, Juncadella, and other printers, send work as good as any of Manchester or Rouen, the only thing remarkable being that the samples show nothing distinctively Spanish, but the styles and execution might have been just as well shown from England or France. In quiltings and cotton damasks Bauvier Brothers make a varied and respectable display, but are behind in finish. Grey and bleached, plain and fancy calicoes are freely shown by other makers.

As regards the prints shown by Spain, by Russia, and by Italy, it is evident enough that the designs are French, and the rollers, in all probability, from Manchester, as well as the foremen and directors; so that there is very little really national about them except the mere underling labour. It is a kind of hothouse forcing of productions neither indigenous nor natural, at a foolish and miscalculated cost of national outlay and protection; and a great pity it is that there are not national statesmen capable of seeing that the same labour employed in indigenous products, under home capital and direction, would be more profitable, and would require no artificial and costly sustaining.

How long will it be ere these statesmen attain the common sense to see that the nation suffices for itself far more rationally and profitably when the peasant clothes himself by an exchange of his hemp or olive oil, than when he spends twice the capital and labour to make his own clothes in a mill sustained by national protection?

## Switzerland.

Switzerland.

The Swiss Turkey-red room is the finest practical display in the Exhibition of prints and grey and dyed cottons. Switzerland has 49 exhibitors in Class 27, chiefly from Zurich and St. Gall. The show of Turkey-red prints is so splendid as to be at first quite confusing. The exhibitions of Rieter-Ziegler and Co. and of Tschudy and Co. are un-

surpassable; while those of Egg, Ziegler, and Co. Jenny and Co., Luschinger and Co., L. Meyer, Fruhler Brothers, Kubli; Barth; Jenny, and Co.; Schiesser, Sulzer, Wiedenkeller, Deutch Brothers, come not far behind. A conjunction of favourable circumstances, plenty of pure water, cheap labour, and steady, determined industry, have given the Swiss evidently the lead of the world in this branch. As an element of their success, too, must be remarked the beautiful grey muslins and prints produced by the Swiss calico manufacturers, eight of whom exhibit, and in their special articles decidedly surpass similar French goods. With all the disadvantages of position and natural circumstances of which the French cotton manufacturers complain with such persistent whinings, and on which they base their claims for protection, the Swiss boldly and successfully face the world unprotected. What disadvantages has the Rouen or Alsatian manufacturer that the Swiss does not labour under still more? And yet he quietly and determinedly sets himself to balance them by such advantages as he can create without any plundering of the national exchequer, or any shutting out of foreign competition. The Swiss show of woven coloured cottons is equally extensive and remarkable; and their display of muslins and sewed muslin curtains from St. Gall, arranged with great taste in the beautiful Swiss salon and along the passage, is not surpassed, nor indeed equalled, by all the efforts of Tarare.

Excellence of the Swiss exhibits.

### Austria.

Austria has thirty-six exhibitors of cotton goods, quite up to the mark in general, and showing as fair an average as our own would do. The yarns and calicoes are clean, even, and well made, as far as can be judged under glass. The Bohemian printers, from Prague and neighbourhood, Messrs. Dormizer, Leitenberger, Przibram, Porges, and others, show good, creditable work. Richter, also, of Bohemia, shows good velvets and velveteens. Graumann, of Vienna, very fair quiltings and plush. It is plain that, as far as capabilities of good marketable productions are concerned, there are few branches of the cotton trade in which the Austrian manufacturers are not already far enough advanced to hold their own against foreign competition without any, or with only a very moderate protection indeed, in the long discussed tariff.

Austria.

### Wirtemberg.

The Wirtemberg Cotton court, with eleven exhibitors, consists chiefly of an excellent display of ticks, drills, and

Wirtemberg.

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ginghams, well worth the attention of our manufacturers. The cotton coatings and trowserings of Schoop & Co., of Biberach, are remarkably good, as well as their ginghams; and capital specimens of similar goods appear in the assortments of Gutmann, Ottenheiner, Kaufmann, and Elsass. Messrs. Staub show well-made plain and fancy greys, and Mr. Faber, of Stuttgart, good quilts and quiltings, with jacquard furnitures of a neat make, worth noting.

## Baden.

Baden.

Baden has only one cotton contribution, a remarkably excellent display of printed muslins and de-laine shawls, by Messrs. Koechlin, Baumgartner, and Co., which seems, however, to belong as much to Paris and Mulhouse as to Loerrach.

## Prussia and North Germany.

Prussia and North Germany.

In the important exhibition from Prussia and the North German Confederation, the bulk of the display comes from those active Rhine-Prussian provinces which take so largely of our Lancashire yarns, through Rotterdam. As might be expected, but little prominence is given to native spinnings, though a few sewing cottons and calicoes are shown. Almost the entire exhibition is devoted to cotton clothing, imitating wool; and an imposing collection of this article is displayed, well worthy the attention of our cotton districts. Messrs. Wolff and Co., of Gladbach, and the Gladbach Cotton Company, show an excellent and varied assortment of dyed and printed swandowns, and other low fustians for linings, &c. a branch in which Rhenish Prussia has long equalled or excelled our own makers. Prices, from 6*d.* to 15*d.* a yard in 25 inches wide. But the most remarkable productions are the useful and economical cloths, of mixed wool and cotton, or all cotton, of which Messrs. Bornefeld, Ax, and Frowein, Zartmann and Co., Nacken, Boetterling, H. Ax, and a dozen others, from Gladbach and Rheydt, show an extensive and capital assortment, chiefly from 9*d.* to 1*s.* a yard. Mr. Mitscherlich, of Eilenbourg, shows a fair variety of quiltings and other white figured cottons. The Power-Loom Company of Linden make a fair show of cords, and a rather imposing display of velvets and velveteens, not quite up to the mark in dyeing; but decidedly noteworthy as the best Continental example of these goods, approaching nearest to Manchester in general excellence. Messrs. Liebermann, of Berlin, and three or four other printers, show work of the Rouen character, but not generally remarkable. From Saxony, Chemnitz only sends one representative, Mr. Hauschild, whose specimens of excellent yarns and threads are noteworthy; and those of Heyden-

reich, and of Hoeffer, alongside, are also remarkable. The principal display from Saxony consists of some good hand and machine embroidery, as well as curtains—which, however, hardly come up to Glasgow productions—shown by Messrs. Jahn, Boehler, Schnorr, Mammen, and others, from Plauen. Some good drills, also, are exposed by Mr. Herzog.

## Belgium.

Belgium.

The last, but by no means the least, of the cotton industries in our tour is that of Belgium. This wonderful little country, whose splendid energies and indomitable national spirit place it on a par in industrial importance with the first countries of the world, and far beyond many of much greater superficial extent, takes, of course, a leading place in this branch, and sends sixty-nine exhibitors from Ghent, Renaix, Tournai, Courtrai, &c. Their cotton court is well planned, architecturally; but the different branches are not as well classed, nor the individual displays, in many cases, as well laid out as might have been. In yarns and calicoes we have about ten exhibitors, rather scattered about, among whom Messrs. De Bast, Desmet Brothers, and Rosseel and Co., all of Ghent, are remarkable. In quilts and quiltings and dimities there are four or five exhibitors, among whom Messrs. Lousbergs and Brac-Vercruysse, of Ghent, are noticeable, and represent well a class of goods which, as well as Belgian calicoes, have entered successfully into competition with our own goods, both in our own and in the French market. But if there be occasionally some advantage in their heavy Marseilles quilts, our other quilts and quiltings are certainly superior in make, finish, and appearance. Only one printer—the Stalle Company—shows a variety of plain work of the Rouen sort, and of ordinary style and execution. There are half a dozen or more makers of cotton blankets from Termonde, remarkable for excellence and cheapness. But the greatest strength of the cotton trade seems put into the display of drills and imitation woollen clothing. About half of the cotton court and half of the exhibitors are devoted to varieties of these mixed or all cotton coatings and trowserings, similar, though with many differences, to the Gladbach and Wirtemberg goods, and constituting, on the whole, a branch of cotton manufacture evidently more important and more developed on the Continent than with us, and which does not seem to have been checked by the cotton crisis or beaten by low woollens, as similar goods have been to some extent with us. The prices, where given, seem often remarkably low, and the styles and makes are very varied. It is not easy to distinguish

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among so many; but Messrs. Hemptinne, Joniaux, Rubay, and Desimpel, Masquelie, Dujardin, Saffre and Graveline, Duchatelet, Gilson, and Bossut, Lienart, Asou, may be mentioned as good representatives of this manufacture, which, were it as largely developed with us, and as important for home consumption and for export as it is with the Continental manufacturers, would certainly excite their emulative efforts. In a separate court Messrs. Van der Smissen Bros. show a remarkable case of yarns and sewing or crochet cottons, plain, dyed, and fancy, in great variety.

## Netherlands.

Netherlands.

I should add that three or four Netherlands exhibitors show a peculiar article, specially for their colonial market, quite singular and characteristic. Mr. Wilson limits his display to a single article, an imitation of the Japanese Batick, remarkable in execution and interesting by its dissimilarity to anything else in the cotton trade. Messrs. Salomonson and Dyk show a greater variety of articles, including Baticks, and all marked by peculiarities of style, suited to their special markets, and worthy the notice of our foreign merchants.

## Conclusion.

Danger to English trade.

Few practical and reflective observers will glance, even as hurriedly as we have thus done, round these competitive displays of industrial ability in cotton manufacture without feeling that, however long and largely England may retain the leadership, anything like an exclusive empire or undisputed sway in the cotton trade is no longer possible. The superior education of Continental workmen in certain branches, or the better position of foreign merchants in regard to certain articles, already reduces us to a secondary position in some respects. If in all countries as excellent a system of public education and as independent a spirit prevailed as in Switzerland, our position would soon be menaced in many more directions. These exhibitions of the rapidly-developing powers of so many rival centres of production must quicken our efforts—by education, by political development, by co-operative interest, by every means in our power —to bring every latent energy of our population to bear in maintaining our position. While we are hovering round the question of national education, and hesitating over the petty interests of parties in regard to it, the industrial sceptre is imperceptibly slipping away from us; and, with practical obtuseness, we shall refuse to see it till the fact is accomplished, and it is too late to mend.

Another important point brought prominently into relief by this Exhibition is the universal adoption by every European country of the cotton trade as a branch of national industry. I don't know that there is one European nation without an attempt to establish it, and several other countries, as the United States, Canada, Brazil, adopt it more or less largely and successfully. Now it is very evident that they cannot all be equally endowed naturally for its profitable working, possessing rich coal fields and iron beds, extensive and easy sea communication, great facilities of internal transport, and large centres of population. To take the European countries only, which have doubtless been led into the attempt by the wonderful example of England; if some in certain branches have natural advantages which enable them to maintain a more or less successful competition with England, as Belgium, France, Switzerland, Rhenish Prussia, and Saxony; the others, Spain, Portugal, Italy, Germany, Austria, Turkey, and Russia, have none or almost none of these natural advantages, and their attempt at a national cotton industry is entirely a forced, unnatural, and miscalculated effort. It is not a national industry but only a national burden, based upon entirely false ideas. And even in those countries better qualified to work certain branches of the cotton trade, the existence of protection shows their acknowledged inferiority to England, and the necessity for a forced contribution from the nation generally in order to maintain a relatively small portion in an industry which openly proclaims that it would otherwise be unable to exist.

As this system is a national loss to the countries thus subsidized for its support, so is it also a loss to England, whose goods would otherwise be used by those countries thus driven into the consumption of dearer home-made goods. But it is a double loss to those countries whose cotton industries work upon a national tax, for not only are they paying home manufacturers a full price and a useless extra duty, but they are precluding themselves from paying the English manufacturer a cheaper price and exchanging at the same time a real and natural home product with a profit. For evidently if commerce, which is simply exchange, were not thus impeded and driven into false and wasteful channels, real national products, yielding a natural profit and developing national wealth, would be allowed freely to exchange themselves for all foreign articles, in place of maintaining artificial industries, which are not national and never can be, and are a charge in place of a source of wealth to the nation.

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Now as protection is only ignorance of true commercial principles, it is not only the interest of England, as the greatest manufacturing and commercial nation, but her duty, as the most enlightened nation on commercial subjects, to make continuous efforts for the removal of this ignorance. And surely no more useful, more necessary, or, viewed in its higher bearings as uniting national interests and tending towards international friendliness, no more noble mission could be given to England's foreign representatives than that of actively taking and making every means to correct these false views, and disseminating those truer and friendlier principles which are also more secure and profitable for all.

It is, it seems to me, to the Chambers of Commerce and Manufactures of England we must chiefly look for initiating and maintaining such a spirit and purpose among our diplomatic and consular agents; and that these Chambers may have due and undeniable influence, a large and enlightened support must be given them by the merchants and manufacturers of the districts they represent, a support not yet sufficiently given, through an ignorant and selfish indifference, which will if continued soon meet its own punishment through the continuance among foreign or rival nations of that progress in many directions of which this Exhibition gives marked evidence.

## Medals.

The value of medals.

The above was written before the awards were known, and I confess it did not seem to me of much importance to know or notice them in the review with which I was entrusted. That a medal may be of some importance to a shopkeeper, or to a worker and exhibitor in any branch of industry in which his individuality stands really apart and can thus be brought into greater prominence, is readily admissible. But in great and complicated industries like the cotton trade, where so many successive hands are employed to attain a final result, and where progress is so much the product of a general movement in which the influence of a single firm or individual is little appreciable, it is scarcely possible that any awards hurriedly made by a jury, often more curiously than suitably constituted, can have any real or practical signification. A little special expenditure, a little special care will produce articles likely enough to attract attention and admiration in an exhibition, though of little or no use in the actual market; as the medal also is itself found to be, for no buyer will pay a penny a piece more for a

printing cloth or a shirting because the firm producing them have obtained a lot of medals. Nor do the medals, even taken in the aggregate, serve in any way to indicate the actual position of the different countries in the cotton trade. Thus we find that, out of 26 gold medals awarded, France, which has already seven leading manufacturers, "hors concours," through being on the jury, has 15, and all the rest of the world put together only 11; Britain having five, Switzerland and Belgium two each, Austria and Prussia one each. Of silver medals France has 75, and the rest of the world 62; namely, Switzerland 13, Austria and Prussia 12 each, Belgium seven, Prussia six, Britain five, Saxony, Holland, and United States two each, and Spain one. And in bronze medals the case is about the same. Now no one can pretend to find in these awards any evidence of the relative positions of the different countries in cotton manufacture. France takes the lead, quite out of sight of all competitors; but if this be the opinion of French cotton lords acting as jurymen, we know how as legislators, or as competitors in view of a commercial treaty, they groan and lament about their distance behind England, which no improvements in machinery and no growth of years ever enables them to diminish. Nor is the way in which the medals are awarded likely to be satisfactory even to those who get them. Thus France, wanting 15 of the 26 gold medals, chiefly for those printers whose costly and splendid products are admirable in an exhibition but very limited in their adaptation to the world's needs, could give only one medal to the half dozen British sewing cotton manufacturers, (grouped together for economy of award and condemned to internecine war over the single bone thrown to so many;) whose one medal, however, represents a production of far more importance in the world's commerce than that of the 15 French medallists. And the only English printer exhibiting, whose work was certainly quite equal in its kind to any of the similar French work, was graciously awarded a "Mention honorable!" Thus also, the two leading French dyers, exhibiting a fair but nowise remarkable set of products, get a silver medal each, and one of them an extra bronze medal as well; but the only English dyer, who exhibited quite as remarkable a set of ordinary products, and a very remarkable set of samples of silk finish, so admirable as to be always taken even by practical men for silk mixtures, of which the French dyers showed and could show nothing, was condemned to a mere bronze medal.

Without then needlessly multiplying instances, it can hardly be contested that such awards, in such industries as

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those connected with the cotton trade, can have little or no practical value or signification, whether taken individually or nationally, and had better be left out of future exhibitions, or at least may be left out of any critical review of such industries. It is also in part the discovery of this uselessness of medals by those manufacturers whose products would add interest to such exhibitions, and whose importance places them above medal-hunting, and in part this perhaps inevitable but at all events certain confusion in their award, which has influenced such manufacturers so largely in abstaining from the display of their products.

## Report on Linen Thread, and Fabrics of Linen and Hemp.—(Class 28.)—By John Stevelly, Esq.

Mr. Stevelly on Linen Thread, &c.

We find in the Paris Exhibition of 1867 the great number of 621 exhibitors in this class, without counting the Belfast trophy, which does not appear in the catalogue; and, although Scotland, England, and America are unrepresented, we have still a show of linens which would have been believed impossible in 1851 or 1855. This Exhibition confirms what we already know by experience—that Great Britain, although doubtless the largest manufacturer of linen goods in the world, has been hitherto by no means a great consumer.

The cotton famine has now forced many to use linen who previously used cotton; and these, I hope, we have secured as permanent customers for our linen manufactures. Such a crisis was not needed to induce the consumption of linens on the continent, where a cotton blouse or a cotton shirt has long been a mark of exceptional poverty.

General arrangement of the exhibition.

It is certainly singularly easy to find anything in the Paris Exhibition, and to compare it with similar products of the same or of other countries. This simplicity of arrangement has doubtless been achieved at a great expense of general effect; but, in a practical point of view, its advantages are immense. To find the linens we enter the building by the Porte d'Jéna, and, after passing the circle devoted to machinery and the smaller one given up to raw materials, we come to the large circular gallery going round the entire building, and headed "Group 4.—Vêtements," which comprises all articles worn, either completed or having gone through some manufacturing process. In this group are included not only yarns and brown and white linens, but also the made-up articles.

Ireland.

Commencing our circuit of this gallery on our left hand, we come to France, whose linen manufactures we shall first consider, not only because we are at present the guests of France, but also on account of their importance. Then follow Holland, Belgium, Prussia, and the Northern States of Germany and Austria; and passing through several countries of minor importance as linen manufacturers, including our own colonies, we come to Ireland, almost at the point at which we started. I say Ireland advisedly, for the absence of Dundee, Dunfermline, Barnsley, and a

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host of other places celebrated for their linens, leaves a woeful want in the British Class 28 as it appears in the Champ de Mars. The unrepresented members of our trade urge their expense, labour, and loss of time at former exhibitions, and the small appreciable advantages which they derived therefrom, as an unanswerable argument against their exhibiting. I believe this however to be a mistake. Even in an economical point of view, it is certainly the cheapest and most telling advertisement An exhibition of the ordinary tissues, however fine, can scarcely be made attractive to the multitude, and this department is, accordingly, almost forsaken for the French jewellery, the Prussian guns, the German toys, and the English and Bohemian glass ; but we must remember that it is these grim bales which mainly contribute to those annual tables of commercial statistics whose enormous totals our mind can scarcely grasp, while, judged by the same standard, the show things sink into utter insignificance,

The French portions of the linen exhibition.

France has not underrated the importance of exhibiting a com plete series of her linen manufactures, but, in common with Belgium and Prussia, she has devoted to it the largest space allotted to any one industry. Certainly the linens exhibited by France have nothing in common with our makes or consistent with our ideas of what she would find most profitable ; we must, however, study these French manufactures as they are, and try to imitate them if we wish France to become to any extent our customer. In a remarkable report to the Belfast Chamber of Commerce by the deputations sent by it to the Paris Exhibition of 1855, for which I am indebted, along with many valuable statistical tables, to Mr. M'Ilwrath (*see note* A.), secretary of the linen-trade committee, it is estimated that the annual consumption of linens in France amounts to 250,000,000 yards. Without accepting completly those figures, which I have no means of verifying, it is yet certain that the consumption of linen goods is greater in France than in any other country in the world. France had at work on 1 Jan. 1866, 226 mills, containing 705,350 spindles, and had going, in the Department du Nord alone, 4,305 power-looms, which latter number has been since so largely increased that the present number of power-looms working in France cannot be estimated at less than 8,000. In addition to the proceeds of these powerful means of production, she imported, in 1866, 3,800,000 lbs. weight of yarn and 3,500,000 lbs. of linen 2,800,000 lbs. of which are brown. These few figures give in a small space all the importance of her linen consumption.

Statistics of the linen trade in France.

Of the above large amount of brown linens we must not fall under the delusion that we sell the principal part. We contribute 200,000 lbs. only, while our intelligent neighbours of Belgium supply 2,500,000 lbs. The Belgians, it is true, are aided by cheap labour; but we have, on the other hand, our immense development of power-looms. What we have neglected to acquire is the experience which the Belgians possess both in producing the goods demanded by the French trade and in adapting themselves to the fancy tariffs of the French custom-house. In the present report I should wish to draw special attention to those particular classes of goods which appear to me the most important for our manufacturers to become acquainted with, and which it would be most easy for them to make their own; so that, in case of a sudden suspension of purchases on the part of a large customer, such as America, or of the reduction or the abolition of the present French tariff, they might be able to avail themselves in some measure of the outlet which France affords them.

French duties.

Allow me to say a word on the subject of the French duties. The present French Government carried in 1860 a comparatively liberal measure in spite of a formidable opposition. A tariff on the principle of a 15 per cent. maximum rate was far from a radical measure; but at that time the intelligent Minister, now the Minister of State, held out the hope that, if the powerful band of manufacturers who opposed any change were neither ruined nor seriously affected by the modification of the tariff the further reduction of the duty would be limited only by the fiscal wants of the country.

During the seven years of the new régime the spindles have increased from 400,000 to 700,000. The power-looms have taken a firm place in the country. The exports of linen yarn and thread have increased from a nominal quantity to 4,000,000 lbs., and the export of linen has reached the enormous amount of 9,000,000 lbs. The sudden general demand for linen might diminish the value of these facts, were it not that precisely the same results have followed in the cases of the cotton and the woollen trades. The French Government has partly recognised these results, first, in the treaty with Belgium, when certain duties were modified, especially on low plain goods and drills; and, secondly, in the beginning of this year, when 20 per cent. reduction was made on the finest class of linen in the special Austrian treaty. Under these circumstances I believe that the time has arrived when it would be most important to

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urge on the French Government to abolish protective duties which the French manufacturers no longer require, or, at all events, to place them at the lowest per-centage which they believe the financial arrangements of the country would justify. A 5 per cent. maximum rate would in all probability greatly increase the revenue. In making such a representation I would especially call attention to the case of heavy makes of coarse linens, and to drills, which are both virtually excluded, and also to the importance to the French manufacturers of having extended to them the beneficial effects of article 40 in the Belgian law on entrepôts, which allows to be taken out of bond, duty free, yarns destined for the manufacture of linens for export. This would allow the French manufacturers to compete on terms of equality with other nations in the markets of the world.

The advantages to France of adopting the Belgian law on entrepôts.

The growth of flax in France.

I hope the reporter of Class 43, to whom this more properly belongs, will excuse my making a few remarks on the important subject of the "raw material." At the beginning of the present century, during the wars of the Empire, owing to the want of labour, the growth of flax was small in France, each household only growing what it required for its own use. Little or none could be exported. In 1822 we find, however, some 35,000 acres under flax, but in 1845 the area falls to 11,000 acres in consequence of the slowness of the French in following the lead given by England and Ireland in adapting machinery to spinning flax. At this time our sales of yarns to France reached in one year the large amount, for the period, of 11,000 tons. It was now clear that hand-spinning was doomed, and with the erection of mills we find the culture of flax gradually increasing. In 1864, in the Department du Nord alone, there were 45,000 acres devoted to flax; and in 1866 we may safely assume that France had at least 60,000 acres under the same crop, besides importing 31,000 tons of flax, principally from Belgium and Russia, 7,000 tons of hemp, and 17,000 tons of jute. The exportations during the same period reach in the aggregate, exclusive of flax straw, 7,400 tons. Notwithstanding these figures, the supply of flax was so evidently inadequate that a few enterprising spinners and merchants of Lille formed, a few years ago, a company for the culture of flax in the colony of Algeria, where the plant was remarked to grow abundantly in a wild state. The success of this speculation is worthy of notice, for last year, three years after their modest commencement, they sold 1,000 tons of flax fibre. We find exhibited, not only by several spinners, but by the "Compagnie de la Culture du

Flax in Algeria.

Lin et Coton d'Algérie," besides exceptional samples spun into yarns, numbering from 100 to 300, a good quantity of medium flax, suitable for spinning wefts, forty to seventy, of good colour, resembling in many respects those better marks of Russian flax which of late years have become so scarce. They have great facilities for the weeding and pulling of flax in Algeria in the large native population who do this kind of work well, cheaply, and quickly. The water for steeping is good, and the scutching-machines used are the best that can be had. As the crop is gathered in May, the produce can be early in the market. The seed also deserves notice; for the grain originally imported from Riga has so much improved after its third year in Algeria that, when tried with freshly imported Riga seed, it gives flax not only 10 in. longer, but with a finer fibre. Trials of this seed, under official surveillance, have been made both in France and Belgium with the like result.

Notice of some remarkable French flax spinners and manufacturers.

Messrs. Droulers et Agache (117) give us examples of this flax spun; and they exhibit likewise an extensive range of well-spun yarns, extending from 10 to 300, shown so as to make the difference between the qualities of flax grown in different districts easily appreciable. Messrs. Le Blan Frères (64 and 120) have also a very creditable collection of yarns. The principal honours of the French department, must, however, be reserved for Messrs. Wallaert Frères (13), both as spinners and manufacturers, who exhibit a collection of family linens and sheetings, all power-loom goods, which certainly show considerable progress, although closely followed by the large manufacturers of Armentières, Messrs. Beghin Duflos, Victor Pouchain, and Mathieu Delangre (9, 10, and 11).

French household linens and the yarn employed in their manufacture.

Normandy was the cradle of household linens, under the name of "cretonnes;" and these Norman combinations are more or less those copied at Lille. Foremost among the large houses of Normandy are the old house of Laniel (93), the first to employ power-looms in France, and still ready to adopt every improvement; M. Fournet and Messrs. P. Marie et Cie., both of Lisieux, who have seen nearly all their smaller neighbours disappear in the unequal struggle between hand and power looms. Even they, with their powerful organisation, have to contend with the high rate of wages, or rather with the difficulty of finding skilled labour in a region so far removed from the present centre of the linen trade. In these goods, whether they be from Lille or from Normandy, the base in the same. The lower sets are 42 in. wide, the finer 36 in., and a little is made 32 in.

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The yarns are well boiled, and we get some idea of the qualities employed by examining the samples exhibited by Messrs. Méry, Samson, Rattray, et Cie. (51), an establishment founded by Messrs. Duffin, of Belfast, and making yarns specially for these goods in 25-40 line.

In these we find a quality of stuff employed in the spinning which would go with us to at least 20 numbers higher, while the prices range from 14*s.* to 12*s.* per bundle.—(*See note* B.)

The setting of the cloth is as follows:—

| | | | | | | |
|---|---|---|---|---|---|---|
| $9\frac{3}{4}$ threads in 5 millimetres or 55 porters | - | - | { | 16 warp, | | |
| | | | | 20 weft. | | |
| 13 „ | „ | 60 „ | - | - | { | 28 warp, |
| | | | | 40 weft. | | |
| $15\frac{1}{2}$ „ | „ | 67 „ | - | - | { | 40 warp, |
| | | | | 55 weft. | | |
| 18 „ | „ | 87 „ | - | - | { | 60 warp, |
| | | | | 80 weft. | | |
| $22\frac{1}{2}$ „ | „ | 102 „ | - | - | { | 90 warp, |
| | | | | 120 weft. | | |
| 32 „ | „ | 136 „ | - | - | { | 130 warp, |
| | | | | 160 weft. | | |

Linens used in the French army, navy, &c.

Messrs. Jongley-Hovelacque, Caron Cardon, et Cie., and Messrs. Duhamel Frères, respectively 5 and 71 in the catalogue, give us all the types of cloth used in the naval and military services, both of which, as well as the hospitals, prisons, and other public departments, unlike our own, have always employed linen in preference to cotton. These types have a special interest for our manufacturers at present, from the fact that, in the last adjudication of a linen contract, the French military authorities, contrary to their invariable rule since 1840, left out the clause in the conditions requiring the contractor to guarantee that the goods are *boná fide* of French manufacture. Of this return to a liberal spirit we cannot speak too highly, and we accept it as a good omen for the future.

Blouse linen manufactured in France.

Messrs. J. Scrive et Fils (67) and a number of others show samples of blouse linens, blue, slate, and drab, in all variety of shades. These cloths are generally made 41 inches to 42 inches wide, although a small portion are in 55 inches; but for our purpose we can study such goods more profitably in Belgium, where the manufacturers, without neglecting the preference given in France to heavy linens, have at the same time kept the French tariff in view. The heavy linens made of dry spun yarn, although forming an important part of the French consumption, have

Sailcloth and other heavy linens.

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less interest for us than the preceding descriptions; still we cannot pass over the exhibitions of Messrs. Dickson et Cie. and of the "Société Linière du Finisterre," from their well-known position in the trade of France. Besides the goods they sell for shirts and sheets in the agricultural districts, they are the principal linen contractors for the navy; and their sailcloth competes with the best marks of Dundee in every market. Nothing could more thoroughly prove the absurdity of their being still "protected" by a 15 per cent. duty in France.

The trade in hempen fabrics.

The trade in hempen fabrics is largely represented in the Exhibition. The peasants use both these and the low linen goods for sheetings and shirtings, and both, after being steeped in a preparation of sulphate of copper, to make them waterproof, serve to make those cart-covers with which every railway waggon, waggon and cart in France is provided. Important hemp-mills are placed in the localities where they grow the largest quantity of the fibre which they employ. The wonderful hemp of the valley of the Loire, the best in the world, is nearly monopolised by the Angers spinners (46, 37, and 76), and they certainly know how to make the most of it, whether in shoe-thread, fishing-tackle, or cloth. In this part of the trade they have no competitor. The hemp of the Sarthe would be insufficient for the quality of hempen cloth made by Barry, jeune, et Cie., and Messrs. Cornilleau aîné, et Cie., of the Mans, whose reputation as power-loom manufacturers is well sustained in the Exhibition. The hemp of Picardy is much used in the north of France, although no house represents it exclusively; and we must mention, in connection with this subject, the exhibition of Messrs. Hambis et Cie., Ligugé (Vienne).

Jute, yarn, and sacking.

Passing quickly over the jute yarns (represented by the Nos. 24, 26, and 55, the latter formerly the director of the large house of Cohen et Cie.), we come to the sacking and hessians of Messrs. Saint Frères, and Messrs. Drummond, Baxter et Cie., both large houses and both spinners as well as weavers, Messrs. Saint alone producing over 70,000 yards of cloth a day. Messrs. Devailly Frères, of Amiens, exhibit the novelty in this department—a sack woven without seams.

French fancy drills.

We find eight exhibitors of fancy drills under the Nos. 101 to 106 and 110 to 112 of the official catalogue. Two districts appear to monopolise this trade—Roubaix, in the immediate neighbourhood of Lille; and Laval, in the Mayenne. In both the arrangements of colour are tasteful, and the goods are well made and cheap. Fancy drills, either in the piece or in made-up articles of clothing, form a large

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item in the linen exports of France. Let me specially draw attention to (105) Messrs. Parent et Danchin, who show very nice fancy drills, 24 in. wide, linen warp and jute weft, at $7\frac{1}{2}d.$ to $11d.$, a new and very useful combination.

Cholet district and its manufactures.

In the Cholet district (represented by the Nos. 1–4 and 86–90) the trade in light linens and in linen handkerchiefs gives employment to about 20,000 looms. There they make also checked Madras handkerchiefs, the colours dyed in the yarns. For these they have an outlet not only in France, but in the remoter districts of Italy, Germany, and Spain, where snuff-taking still lingers. This class of goods is, I believe, unknown to our manufacturers. Cambrai is also an important centre for the finer handkerchiefs, and for fine linens. The wages are higher than in the Cholet district, and the weavers are singularly intelligent. Eight manufacturers give a proof of this in a very varied exhibition. The three of those first on the list, Messrs. Vinchon et Basquin, M. Bricont-Molet, and M. Bertrand-Milcent, show a beautiful series of "batistes," which are made from hand-spun yarn, and to which the town of Cambrai has given its name, and also of more ordinary fabrics. If one had an opportunity of visiting M. Bertrand-Milcent's important power-loom factory, of comparing his goods and prices with ours, and of asking his opinion as to the danger of English competition, I think his answer would settle for ever the question of the necessity of maintaining a duty for the protection of this class of goods in France.

The "batiste" of Cambrai.

Linen thread of Lille.

The thread of Lille, which is exhibited by eighteen of the principal makers (27 to 45), including such names as Descamps, Humbert Frères, Crespel, and Verstraete, shows what good dyeing and finishing can do for cheap thread. I think, however, that in this case low prices and a convenient way of balling sewing-thread have more to do with their success than the intrinsic value of the article they make. The yarn bleaching of Messrs. Vandewynckele (128) deserves notice both for colour and for the roundness of the thread. Although not falling under the class on which I am reporting, I may be permitted to mention here the new system of bleaching yarn of Messrs. Jarrason, and A. Bastaert, of Lille, which has been adopted by several large manufacturers in France. I hope we shall have the valuable opinion of Dr. Hoffman, the reporter of Classes 44 and 45, upon this invention, and also upon the attempt which has been made by Messrs. Tessie du Motay and C. R. Maréchal to substitute or the action of the sun in bleaching that of a preparation of the permanganate of soda or potash.

Yarn bleaching.

The progress which has been made during the last 10 years in the damask trade in France is most remarkable, and the dazzling show of French damasks in the Exhibition, and the number and importance of the exhibitors, show that damask goods are now fast taking their proper place with the consumers, and replacing the plain linens and low diapers which were formerly in almost universal use as table linen. The show of everyday damasks of Messrs. J. Casse et Fils (12) is very creditable, without considering their two chef-d'œuvres, which it would require the more authorised pen of an art-critic to discuss ; as also are those of Messrs. Deneux Frères (96), Messrs. Danset Frères (14), who need fear no competitor in their ordinary sorts, and M. J. Joanard, of Paris (92), whose designs are very beautiful, and so varied that every taste may be satisfied except that of the admirer of geometrical patterns, of which I do not see a single example.

Damasks in France.

An honourable mention is due to Mr. Turquet, of Senlis, who has devoted himself to bleaching and finishing damask goods. Those in this Exhibition are nearly all bleached by him and do him great credit, although his name does not appear in the catalogue.

Algeria has nothing worthy of note in Class 28. The few wretched examples of native manufacture are most uninteresting. I sought in vain for something analogous to the " Algerian stripes," made at one time largely in Belfast, of which the Arabs make the unique article of clothing worn in the tents during the hot weather. The interest in this country is more in its flax, to which I have already alluded. It is singular that, during the plague of locusts which devastated Algeria last year, while every other green thing was devoured, the flax plant was generously spared.

Algerian exhibition.

Holland being our customer for 250,000*l.* worth of yarn yearly, I cannot speak evil of her linen manufactures ; but, as I cannot praise them, I have no other course than to proceed to the next country on our circuit.

Holland.

Belgium shows much in common with the Lille district. The separation of French Flanders is of comparatively recent date ; and the foundation of the linen manufacture in this part of the Continent is attributed to certain barbarous tribes from the region of the Caspian Sea, who are said to have settled in this district some 300 years before the Christian era. Whether there may be truth in this legend or not, it is certain that Flanders linen can be traced back to a very early period. At the time of the first invasion of Gaul by the Romans these northern people wore the

Belgium is early noted in history for its linens.

"sagum," or blouse, which is still the national dress. Belgium offers many advantages for the development of the linen trade. The climate is very suitable to the growth of flax, which is accordingly of excellent quality; the water for steeping it is well suited to the purpose, and abundant; and a great amount of care and skill is employed in its cultivation and preparation. The inhabitants are naturally industrious, and are well trained by centuries of traditions; and the Belgian flax has always been esteemed the best in the world. The quality has, however, of late years been below the average, from the desire of the farmers to produce the greatest possible quantity on a given surface, which could only be effected at the expense of the quality by the employment of guano and artificial manures, whose effect is no longer doubtful. The growth of flax has by no means increased in the same ratio as the prices. In 1840 we find the production estimated at 21,000 tons; while in 1864, with the prices trebled, the quantity grown is estimated at 25,000 tons. The larger proportion of the finer descriptions finds its way to Belfast and England, the middle sorts and the coarse flax are bought by the Lille spinners, or go to supply the 250,000 spindles which turn in Belgium itself. The total exportation of grey yarn is to an amount of about 600,000*l.*, and of bleached yarn and thread about 400,000*l.*, making in round numbers a total of 1,000,000*l.* Of this nearly half is sold to the neighbouring Prussian State, and the remainder is divided between Holland, France, and Switzerland. The exportation of linen from Belgium reached in 1864 the imposing amount of 1,600,000*l.* France heads the list of customers by taking 440,000*l.* worth; Holland buys nearly as much, while the wonderful little island of Cuba absorbs 185,000*l.* Prussia and Switzerland take 100,000*l.* each; and, although the Hanse Towns figure for over 160,000*l.*, a large portion of that sum must no doubt be attributed to Russia, as she only received directly for 70*l.* The remaining 175,000*l.* are distributed over the globe. These results are really surprising in a country with a population of four millions and a half.

Growth of flax in Belgium.

Linen yarn exported from Belgium.

Belgian exports in linens.

Amongst the most remarkable of the Belgian manufacturers is the well-known name of M. Rey Aîné, of Brussels, who, after a long life devoted to this trade, finds himself, as he tells us, at the head of 750 power-looms, and nearly double the number of handlooms, employing some 4,000 workers, and producing over 11,000,000 yards of linen annually, embracing nearly every class of goods. I propose drawing attention to the most remarkable varieties of

A remarkable Belgian manufacturer.

Belgian linens only, and to those manufacturers who appear to me to succeed best in their specialties.

Courtrai linens and other linens for shirtings.

Amongst these I class shirting as the most important; and the combined exhibition of Courtrai and Roulers gives us ample means of judging both of their merits and of their defects. Among the latter I would class an inferior bleach, and perhaps a somewhat smaller quantity of weft, than we are accustomed to, and an overboiling of the yarn, which renders it soft and gives it a tendency to form small lumps in the after processes. The yarns are, however, excellent, the cloth is well woven, and the prices are moderate, as may be judged by the quotations of more than one of the exhibitors. Taking the excellent example of M. Van Acker (16), or M. Parmentier (51), we find the following quotations for 4–4 light medium linens, by the number of threads in the warp:—(*See note B.*)

| Threads in Warp. | Per Metre, Fr. | Per Yard. |
|---|---|---|
| 3,400 | 1·90 | 1*s.* 4¾*d.* |
| 3,800 | 2·10 | 1*s.* 6½*d.* |
| 4,200 | 2·40 | 1*s.* 9*d.* |
| 4,600 | 2·80 | 2*s.* 0½*d.* |
| 5,000 | 3·25 | 2*s.* 4½*d.* |
| 5,600 | 4·75 | 3*s.* 5½*d.* |
| 5,800 | 5·25 | 3*s.* 10*d.* |
| 6,400 | 6·50 | 4*s.* 9½*d.* |
| 7,000 | 8·50 | 6*s.* 2½*d.* |

Sheetings.

And I consider these lower figures a valuable indication of the cheap rate at which they can work. Of course, above 5,600 these are only Exhibition goods. In the sheetings exhibited by the same houses and in those of M. Dathes (8) and M. Denys (9) we have examples of goods used largely on the Continent, especially in Spain, Italy, and Germany, which are little made with us. They command a large sale, for they are of good material, and lighter and cheaper than goods of the same class of British make.

Blouse linens.

Many houses exhibit blouse linens, of which the sale is very important; it will be sufficient to mention M. Tant-Verlinde and Messrs. Van Damme Frères, of Boulers (55 and 57), M. Parmentier, of Iseghem (51), and M. H. Van Bradander (375), of the Belgian catalogue. I consider M. Parmentier one of the most successful of the Belgian manufacturers. He has adapted his goods with the greatest intelligence and success to the countries with which he deals, whether in the strong makes for Switzerland and Germany or in the lighter makes for France. The immense sale of these goods naturally

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draws our attention particularly to them, and, seeing them, a manufacturer will have little difficulty in imagining that Belfast, paying the same duties for their entrance into France, cannot sell a single piece, and, after many trials, has fairly given up the attempt as hopeless. The whole of the trade is thus left in the hands of Belgium, whose sales are estimated by millions yearly in this one article, the range being 10°° to 18°°, and nine-tenths of the sales in the three middle numbers, 13, 14, and 15. The difficulty in attaining an object of the greatest importance often lies in the very simplicity of the means required; the most trifling element neglected spoils all. Let me lay down a few rules on which all are agreed. Brown, width 44 in. full, avoid streaked yarns, as every shade will not only show after the cloth is dyed, but will be emphasised by the indigo; light blue coloured yarns are very much preferred, as they dye best; gold-yellow colour passes, but Irish flax is considered unsuitable, from the variety of shades. I fancy that could be obviated by sorting to colour as well as to quality. It should be well understood that the question of colour is one of the very first importance. The yarn should be well boiled.

Settings vary, but the following may be taken as the average:—

| | | | | |
|---|---|---|---|---|
| Count by 5 millimetres - | 12 | 13 | 14 | 15 |
| Warp „ „ - | 40 | 45 | 50 | 55 |
| Weft „ „ - | 65 | 70 | 80 | 85 |
| Price per metre approx., fr. - | 1·20 | 1·30 | 1·45 | 1·60 |
| Price per yard - - - | 10½*d.* | 11½*d.* | 12¾*d.* | 14*d.* |

Two shots over square of weft at least: some make four shots, but with fine weft like the above that is easy. Some quantity is also made in yarns coloured with pounded slate. The Belgians had this assimilated to brown linens in their Treaty, and we enjoy the benefit of this clause. In any case the goods must be well picked and cleaned, especially for dyeing purposes. There is another important point; the calculation of cost must be based upon a large quantity, and not upon a few samples, otherwise the manufacturer is disappointed and tires of working at a loss, abandoning an enterprise which might probably have succeeded if commenced on a scale of a certain importance. Some makes of these goods are much stronger; and this Exhibition affords, as I have already stated, a very valuable opportunity of studying them in every variety. Their study is much facilitated by the very general habit amongst the exhibitors, as men conscious of their strength, of

giving us widths, prices, counts of threads, and numbers of yarns.

The cheap labour in Belgium is doubtless a difficult element to contend with; but sooner or later it must follow the general advance. Although the goods produced by our power-looms are now more costly, their price is diminishing day by day by new inventions and by the improving skill of the weavers; and they are at all times more regular. All these considerations should encourage us to emulation.

Drills.

The Belgium drill, of which, however, we have but few examples in the Exhibition, are remarkably good value. We have an opportunity of judging of them in the samples of Messrs. Cornille-Bartholomeus et Bartholomeus Frères, and one or two others.

Hessians.

Hessians figure very creditably. M. Van Robaeys (20), who shows 30-in. wide sacking, at $4\frac{1}{2}d.$, and made-up sacks, 30 in. by 40 in., at $9\frac{3}{4}d.$, is not exorbitant; while Veranneman et Sœur (61), who quote 40 in. Hessians at $5\frac{1}{2}d.$, are, perhaps, even cheaper. A step higher in manufacture, M. William Wilford, of Tamise, whose name indicates his nationality, shows as good a collection of sailcloth as if his manufactory had been at Dundee.

Sailcloth.

Belgian flax spinning.

One word here in praise of the intelligence of the Belgian spinners who have struck out for themselves a new path which, so far, no English spinner has disputed with them—making a class of yarn which is almost unknown to our manufacturers, and which has contributed greatly to the success of theirs, especially in the manufacture of cloth for dyeing. The samples exhibited by the Société de la Lys and the Société Linière Gantoise perfectly justify the competition which exists for their produce and explain their enormous and well-sustained profits, as well as their very high prices:—(*See note* B.)

| | | |
|---|---|---|
| 1st quality, 40 to 100, at about | | 10*s.* 0*d.* |
| 2nd ditto | „ „ | 9*s.* 6*d.* |
| 40 to 70, in Russian flax | „ | 7*s.* 0*d.* |

M. Simon-Boucher, of Tournai (74), speaks of the success he has had in his wet-spinning by allowing the fibre to remain a much longer time than has been customary in the water; he also exhibits some fine samples of spun hemp.

Hand-spun yarn.

Sample of hand-spun yarns ranging from 200 to 1,600, exhibited by M. Devos, remind us of the past, and afford a striking example of the perfection of hand labour compared with that of the most perfect machines. The blind, aided by their fine sense of touch, succeed best in this delicate manipulation.

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The Belgian handkerchiefs are but poor; and the damasks, of which there are several exhibitors—the best, perhaps, Messrs. Noel Frères, of Alost (69), and M. Brandt (2)—are indifferent in pattern and detestable in bleach.

Damasks, &c.

Thread trade in Belgium.

I have in vain searched the Exhibition for an explanation of the fact that in 1864 Belgium exported 300,000*l.* worth of linen thread, while England in 1866 exported only for 510,800*l.*, and France for 100,000*l.*

The samples of Messrs Ch. de Coq and Co., of Lokeren, and Messrs. Declercq et d'Huyvetter, of Iseghem, which appear to be the best of their kind, only add to my embarrassment.

From France and Belgium we have much to learn; I have therefore thought myself justified in studying their productions somewhat in detail. In dealing with the remaining countries we can afford to be comparatively brief.

Prussia and the northern States of Germany.

Prussia and the northern States of Germany, however, still present important fields of manufacture, of which the nearest home is Bielefeldt, whose linens are well known, not only in Germany and Russia, but also in France and Italy. The celebrity of this region for fine linens dates from the time of hand-spun yarns. Of this we have many proofs even in this Exhibition. Above $21^{00}$ these linens are admirable; below that number I think their prices must shut them out from every market where an old and honourable connection does not weigh in their favour. Of these fine linens we can have no better example than those of F. G. Kroenig, whose existence dates from the year 1763; and of Bertelsmann and Son (20). The sale of this very fine linen is of course limited. Here they push it by turning it into shirt fronts by the aid of sewing-machines. Herr Westermann (3) and Herr Heidsieck (4) give us some good examples of well-executed damask, which appears, however, to be an accidental article of manufacture in this country, entirely devoted to plain fine linen. Side by side with these fine goods and this old-fashioned trading, we find modern industry represented by several large flax-spinners and power-loom manufacturers, such as the Bielefeldt Company (28), the Ravensberg Company (34), the Vorwörts Company (29), Herr Mevissen (35), Herren Schoeller, Mevisson, and Bückler, of Düren (36), and the Viersen Spinning Company (37), who average 15,000 spindles each, and many of them have large power-loom factories. These establishments, put up recently on our own models, only interest us as a pupil's success must always interest his teacher.

Bielefeldt fine linens.

Damasks.

Flax spinning in Westphalia.

Viersen Spinning Company.

Passing north from Bielfeldt, we reach Osnabrück, where we find that the old-fashioned manufacture of that name is still a reality. The Hanoverian market officers who measured and sealed only a part of their cloth last year, state that the value of the linen which passed through their hands amounted to 170,000*l.* In this neighbourhood Herr Aschrot, of Cassel (42), is certainly the most remarkable manufacturer. He appears to make every kind of goods, from white shirtings to Hessians, at 4*d.* a yard, including dowlas, russians, and many other familiar names. I particularly noticed a hessian made nine yards wide on a five yard wide loom by the system of doubling, long since applied to silk,

Mr. Stevelly on Linen Thread, &c.

Osnabrück.

Leaving Hanover, we come to the classic land of damasks, Saxony, which, however, leaves its reputation in the hands of but few exhibitors. Herr Joseph Meyer, of Dresden (57), besides his special piece, Rembrandt and his Wife, gives us many cloths excellent both in design and bleach; and Herr Proelss (58) is a manufacturer above the average. The 2,000 looms of Herr Fraenkel, of Neustadt (44), enable him, with his ordinary goods, to make, perhaps, the best show of damasks from the district; at all events, they justify his success as a manufacturer, for he commenced in 1855 with two looms, and gradually extended his trade to its present importance. The exhibition of the above-named Dresden houses is no doubt creditable; but I should have liked to have seen more numerous samples from Zittau and its neighbourhood, where damask manufacturers are plentiful, to have compared their goods with those of France, and thus to have been enabled to judge what portion of the old and wide-spread reputation of Saxon damasks is real and how much is kept up through tradition.

Saxon damasks.

H. Waentig and Co., of Zittau, show an excellent collection of fancy drills, both linen and mixtures, for which they have a sale of 30,000 pieces yearly; and in plain power-loom goods Herren Kaemelo, Erben, and Co., of Gross Schöneau, makes a very saleable article 8*d.* to 1*s.* 6*d.* a yard. Herr C. T. Matthes (56) and Herr Neumann, of Eylau (60), have an excellent display of "listadoes," used like those we make ourselves, for negro clothing in the West Indies. In Germany they have given a much greater variety to these goods, and have thus secured a larger share in the trade than we have done in Ireland.

Drills and listadoes made in Zittau or its neighbourhood.

Nos. 45 to 50 form the collective exhibition of Lauban, and are almost entirely devoted to linen handkerchiefs. These goods are perfectly got up—weaving, bleaching, and finishing. Many manufacturers employ 300 or 400 looms,

Lauban and its linen handkerchiefs.

Mr. Stevelly on Linen Thread, &c.

and the manufacture of these goods fully justifies the favour in which they are held by all, and especially by their Russian neighbours.

In the Russian trade, Irish linen handkerchiefs have always found them the most formidable competitors.

Silesian manufacturers of note.

We are also favoured with an exhibition of the products of the "Kramsta," one of the largest houses in Germany, if not in the world. The mill, it is true, has only 17,000 spindles on flax, and the power-looms are only 500 in number on linen goods; but, between their linen and cotton manufactures, they give employment to 10,000 persons, and are buyers of 420,000 bundles of English yarn yearly. Erdmannsdorf (68), the King of Prussia's model flax-mill, is a large concern, on which nothing has been spared to put it on the best footing. Some 4,000 persons are employed, and they give us a good idea of their makes in drills, diapers, and family linens.

"Hanse Towns" in statistical tables.

Before leaving Prussia, I must express my regret that the exportation from England for this country, as for many others, appears under the head of "Hanse Towns." This prevents us from knowing exactly what sum we sell to each country, I think our trade with the Silesian part of Prussia is improving under the present tariff, although a wide margin is still left for reduction.

Prussian duties levied on linen and yarn.

| | £ |
|---|---|
| On grey yarn the duty per ton is about - | 6 |
| On bleached yarn „ „ - | 12 |
| On grey linen „ „ - | 12 |
| On white linen „ „ - | 30 |

On fine yarns this is not perhaps enormous; but on the yarns for the Saxon drills and damasks it is very heavy, and something might perhaps be done towards having it reduced.

Austria.

The linen trade in Bohemia.

Leaving here the order of the catalogue, which separates Prussia from her late adversary by the kingdom of Wirtemburg, it will be simpler to cross the Austrian frontier. Here a close resemblance to what we have seen in Prussian Silesia points clearly to the common origin of the manufactures of both sides of the mountains. In this industrious and thriving country the standard of living is low, and the present rate of wages reminds one of the scale in Ireland fifteen years ago. The war of last year fell heavily on the inhabitants of this district, and nearly every village, known before only for its linens — Trautenau, Nachod. Hermannseifen, Rumburg, and many others—has now given its name to a battle. As it has turned out the war has

proved only an episode, and the number of mills built or now building will, no doubt, in a few years, make a great change in the linen industry in this patriarchal country, for which nature has done so much. The great manufacture, both of this district and of Moravia, is fine linen, and the principal peculiarity of the manufacture is the common use of bleached yarns; these they handle in a very superior way, otherwise their weaving them at all would be impossible, as they use daily, yarn as fine as 180 in the weft. The Exhibition is wanting both in a series of manufactured goods and in samples of the yarn; still a poorer show of linen than that of Austria might be redeemed by the goods of Herran Rayman and Regenhart (25), as their quality places them first of their kind amongst the Continental exhibitors. The variety is not great—a tablecloth made for the Emperor of Austria, with a few plainer damasks, a range of linen handkerchiefs, and some fine light linens, but every one must be struck by the perfection of bleach of these latter. A. Küfferle and Co., a Vienna house, who have their manufactory at Frievaldau, a village in Silesia, amply prove that the art of making good damasks and cheap handkerchiefs, with a bleach only to be found elsewhere in Ireland, has taken deep root in the country.

Wirtemberg.

Wirtemburg has in Herr A. F. Lang a manufacturer of more than ordinary merit. He shows excellent reproductions of our own light linens, made both by power and by hand labour. We must regret however that his "bleubeuren bleiche," however great its name in Germany, has not yet attained our standard. The damasks of Herr Faber, of Stutgard, and the fancy drills of Herr Kissel are very excellent.

Switzerland.

Switzerland, the next country in the list, has also cheap labour; but I could only find in her exhibition the fancy drills of M. Schoop-Vonderwahl, worthy of notice. Spain, by poor samples of manufacture, shows the effect of a long continued system of protection.

Spain.

Spain is by far our largest customer for yarn, her purchases amounting in 1866 to three quarters of a million sterling in value; but her manufacturers are not sufficiently excited by competition from without to make any figure in the world's show.

Portugal.

Portugal buys nearly all its linens from England, amounting in value to about 50,000*l.* a year. The climate does not seem to suit the manufacture of anything except the very coarsest towelling, hessians, sailcloth, and such coarse fabrics.

Mr. Stevelly on Linen Thread, &c.

In Greece I could see no signs of the exhibition announced in the catalogue.

Greece.

Sweden.

Sweden shows us some damasks and plain linens, made apparently a century ago; but the sailcloth of Messrs. W. Gibson and Sons might have come from Dundee to Paris.

Russia.

Russia is certainly advancing. She employs good materials, and makes an excellent article both in yarn and cloth. Both the Baltic and the Sammerfors Companies (12 and 15 respectively) give excellent samples; the former in yarns, the latter both in yarns and linens, fine and coarse. The native manufacturers in white shirtings, hessians, &c., present some interest; but perhaps the most important exhibitor is the Russian Government, which shows the types of linen employed in its naval and military services, giving the weight, width, and price of every article.

The Italian section.

In the Italian section I was struck with the quantity of embroidered towels, of which many were at one time made in Ireland. The Italian linen manufactures may have held a high rank in past ages; they certainly have but little in common with the present, although I could name several honourable exceptions.

Turkey.

Turkey has thirty-seven exhibitors, but their collective productions would go into a carpet-bag. The primitive appearance of these goods is their principal merit.

United States.

The United States do not even put in an appearance. They are too intelligent not to feel that, even with their natural advantages and Saxon industry, their protective system prevents their competing on an equal footing with European nations, and they are too proud to figure by the side of Spain or Italy.

Great Britain.

Statistics of its linen trade.

During the last few years the linen trade of great Britain has made a prodigious stride. The declared value of linen manufactures, exclusive of yarn, exported from the United Kingdom during the 11 months ending Nov. 30, 1861, was 3,592,157*l.*; for the same period of the year 1862, 4,585,170*l.*; of 1863, 5,806,522*l.*; of 1864, 7,505,226*l.*; of 1865, 8,244,118*l.*; and of 1866, 8,885,595*l.* This extraordinary development, I need not say, has been mainly due to the unnatural stimulus of the cotton famine. It is greatly to be regretted that Barnsley, Dundee, Dunfermline, and the other minor centres of the linen manufacture of England and Scotland are unrepresented; in their absence, however, the credit of the British trade is fully sustained by the unrivalled exhibition of linen goods from Belfast. Crowded into this small court we have every article which

can be made from flax, each unsurpassed of its kind, from nail-bags made of scutchers tow to the finest linens and damasks.

Belfast.

In the Exhibition of 1867 the manufacturers of linen and yarn of the north of Ireland have received four gold medals and one silver medal, an amount of honour higher than has been awarded to any other district or to any other industry.

Lest anyone unacquainted with the machinery employed in the distribution of these prizes should ascribe any portion of that success to partiality on the part of the judges, it is right to state that of the eight members of the linen jury only one was an Englishman; and it is said that he, with laudable delicacy, allowed his colleagues to decide upon the merits of his countrymen. Belfast may now certainly be said to have fully established her position as the metropolis of the linen trade.

The progress of the Irish trade.

The extraordinary advance of this industry, and the enormous importance which it has now acquired, may be gathered from the following figures:—In Belfast and within a radius of seven miles, the value of the spinning-mills, including buildings, steam-engines, and machinery, is estimated at 2,700,000*l.*, and the power-looms at 300,000*l.* The imports of flax seed, flax, tow, linen yarn, and thread to this district amounted for the year 1866 to 2,117,500*l.*; and the exports for the same period to 7,150,000*l.*

The Belfast trophy.

The most striking among the gold medallists is undoubtedly the Belfast "trophy," or collective exhibition, to which 30 of the leading firms of the Belfast district are contributors, and which forms a small museum of the products of the trade. It contains samples of power-loom warps, first, second, and third qualities, from fine to coarse, with the wefts to suit; strong and light linen warps, with fine wefts up to 300; and the different qualities of tows.

The prices of all these are seen by reference to the Belfast linen trade circular, better than by any price-list. Perhaps the power-loom linens may be found the most interesting item. They are in all descriptions, 7°° to 20°°, narrow and wide, from lawns to strong makes. In fineness and regularity in weaving these goods are not only unequalled but unattempted elsewhere, and yet nothing in the case is made specially for the Exhibition—a thousand pieces of each could be produced of exactly the same quality on the shortest notice.

Irish exhibitors and their goods.

In fine fronting linens and lawns Belfast has kept up its old reputation; and cambric and linen handkerchiefs, white, printed, sewn, or embroidered, are shown in every form.

Mr. Stevelly on Linen Thread, &c.

The damasks are also in great variety; but, unfortunately, the small space prevents their being seen to advantage; even those selected for the most prominent place, and made for crowned heads, are exhibited rather for the bleach, and only a judge can appreciate the perfection of the execution.

The one peculiarity of all the Irish exhibitions, which strikes every passer by, is their splendid bleach. This seems natural to the country, and for perfect colour, unaltered strength of the tissues, and cheapness of production, forms a wonderful contrast to the foreign courts.

In the Belfast court we have such a multitude of goods for different purposes, and for the use of different nations, that it is hopeless to attempt to notice all, though each is of vast importance as an article of trade. We have linens for American clothing; drills equal in quality to any made at Barnsley, and produced in Belfast at a much cheaper rate; towelling, sheeting, tailors' and shoemakers' thread; the goods sold in South America and the West Indian markets, from the listadoes for the clothing of the negroes to the creas, or the plutillas, silesias, estopillas, and grano di oras, half hidden in their rich ornaments; and printed linen cambric dresses, an article hitherto almost unknown, which has found many admirers among the foreign ladies. These types are to be found repeated more or less fully in all the Irish exhibitions, except, perhaps, in that of Mr. John S. Brown (3), who has won his medal through the special merits of his damasks. Mr. W. Girdwood, of Belfast (9), gives the only examples of linens printed in anything like variety. Mr. Girdwood's skill as a printer is too well known to require praise, and the samples which he has shown are neither better nor worse than his everyday work. He deserves double credit for the beauty of the linens which he has selected for the purposes of his art.

The honours accorded to Belfast must be accepted as addressed more to the trade generally than to individuals, else we could scarcely explain the distributive justice which adjudges a silver medal only to the unsurpassed exhibition of Messrs. Matier and Co. (13); and Mr. Ainsworth's threads, I cannot but think, with due respect to a decision which is now irrevocable, deserved something more than a mere "honourable mention." The linen trade of Great Britain cannot but be gratified by the generous award of the international jury.

Note A.—I am likewise indebted to Mr. V. Vinelle, Secretary of the Lille Committee "du Journal Circulaire du Marché Linière," for many interesting statistics and papers relating to the French linen trade.

Many of the figures and facts which I advance with reference to Belgium and Prussia, will be found in the official catalogues of those countries.

Note B.—To render quotations of prices comprehensible to English readers, it is necessary to bear in mind that at the time this report was written the common weft yarns of Belfast were selling, Nos. 60 to 100, above 6*s.* per bundle 38 inch wide. Light power-loom linens 10*d.* per yard, and 17$^{00}$ light medium linen at 16*d.* brown.

REPORT on the WORSTED TRADE.—(Class 29 and parts of Class 43 and Class 56.)—By the DEPUTATION of the BRADFORD CHAMBER of COMMERCE. REPORT ON THE WORSTED TRADE.

FOLLOWING the example of 1855, the Council appointed Messrs. Venimore Godwin, Charles Stead, Alfred Illingworth, and George Motley Waud as a deputation to report on such portions of the Paris Exhibition of 1867 as might concern the worsted trade of this district in its various departments. Names of Reporters.

The deputation met in Paris on June 5, and proceeded to examine the wools in group 5, Class 43; the tops, yarns, and worsted fabrics in group 4, Class 29; and the worsted machinery in group 6, Class 56. They have to express their acknowledgments to the various gentlemen to whom they had occasion to apply for information, especially to M. Larsonnier, Member of the Chamber of Commerce of Paris, and President of Class 29, group 4.

## WOOL.

The collection of wool from almost all parts of the world under one roof rendered two facts very striking. The one, the absence of any adequate substitute for English deep grown wools; the other, the slow rate of improvement in those wools of foreign growth which are used in aid of the lower qualities of English combing wool. As to the first of these points, your deputation found reason to believe that however largely inferior foreign wools—such as Algerian, Persian, Chilian, Montevideo, Turkish, and other wools of the Levant—may be used for combing purposes in the Bradford trade, they are utilised by French manufacturers comparatively to a much greater extent. Wool.

With regard to the second point, your deputation examined with much interest various samples of alpaca, mohair, and foreign deep grown wools, and endeavoured to estimate their increase and improvement, questions to which the Wool Supply Committee of the Bradford Chamber of Commerce has directed so much attention.

The Acclimatisation Society of Victoria shows the progress made in the production of alpaca wool since the first results of the importation of alpacas into that colony, which were exhibited in 1862. It is clear that alpaca wool can be grown in Australia, but there is hardly sufficient evidence Alpaca.

REPORT ON THE WORSTED TRADE.

Mohair.

that the experiment has been worked out to the extent necessary to decide whether the true alpaca character can be not only produced but retained and perpetuated. The growth of mohair appears to have been more generally attempted. Mohair is shown from Victoria, from the Cape, from the United States of America, and from the Banda Oriental; and there is evidence of the efforts which continue to be made to naturalise English long wool in our colonies—as shown, for instance, in the case of Mr. J. H. Angus, of Collingrove, South Australia. In all these instances a wool of serviceable character is produced; but, however successful the first clips appear, the great difficulty seems to be the tendency to deteriorate, and to obviate this will apparently require much effort and some time. But, on the other hand, there is ample evidence of a capability of improvement in the native wools of many countries, which have length enough but want regularity of staple. And it would seem that, from the improvement of the wools of various countries, apart from the naturalisation of new types, we have reason to look for such a supply as will in course of time materially supplement the home growth of the lower classes of English wool. For instance, while on the one hand the splendid show of merino combing from Venezuela and Uruguay gives promise of a large addition to the Australian class of wool, in the other direction the native long wool shown by the Argentine Republic only requires to be improved from a bad-bred to a true-bred wool to become of great value to the Bradford trade.

Australian wool.

Your deputation could not fail to notice the marked extension in the use of Australian wool in French goods, and that not only for weft but also for warp. Very beautiful specimens of its use for both purposes were shown by the colony of Victoria in the shape of poplins and merinos, manufactured by Messrs. Siebert, Ledouz, and Co.; and in shawls and printed goods, by Messrs. Larsonnier frères, and Chenest. The report prefixed to class 29, group 4, in the French catalogue, states that the importation of Australian wool into France, which in 1855 was not large, had risen in 1865 to 50,000,000 lbs., or probably upwards of 140,000 bags; and the importation of wool from other countries in the same year amounted to 110,000,000 lbs. The report of the deputation from this chamber, in 1855, went very carefully into the varieties of French wool, and their adaptation to the production of French goods. But it is very evident that the French no longer rely upon their home-grown wool to the extent they did, and are indebted to the Australian colonies and River Plate wools for the greater

French wool.

part of the increase in their production of fine goods. The same remarks apply to Germany, though to a less extent. The Australian and New Zealand colonies may well feel proud of the magnificent wools they show in this Exhibition and of the extent to which they are produced; for without them the manufacturers of England, France, and Germany would be in a very different position.

## Machinery.

Machinery.

In machinery, group 6, Class 56, but little is exhibited that is novel or superior to that which is already in use in the Bradford Trade, and exhibited by Messrs. G. Hattersley and Son; Mr. G. Hodgson, Messrs. Keighley and Co., Messrs. Leeming and Son, Messrs. J. and S. Smith, and Messrs. Sowdon and Stephenson, and for which a gold medal has been received by Mr. Hodgson and Messrs. Leeming and Son; and silver medals by Messrs. G. Hattersley and Sons, J. Keighley and Co., and J. and S. Smith.

Looms.

For general purposes the best looms are, beyond comparison, those by the well-known makers of this district, the demand for which for exportation continues from every foreign country competing in the production of worsted goods. In frames, the French appear to introduce the throstle to a limited extent, but still draw on what is known as the French system, and spin chiefly on the mule.

## Tops and Yarns.

Tops and yarns.

Tops and yarns are exhibited in large quantities (especially by France) of every description except alpaca, which the French do not as yet succeed in spinning. In Roubaix, mohair has been recently spun to a very small extent, and considerable progress has been made in spinning the coarse wools on the mule and the better numbers on English throstle frames. But though the Roubaix spinners are evidently paying great attention to the spinning of long wool, they have not yet attained the Bradford standard. France, however, preserves the same superiority in the spinning of fine yarns for all wool goods which England shows in yarns for mixed fabrics, and is closely followed in this respect by Germany. Amongst other cases of yarn might be noticed the fine warp of wool and silk shown by P. Dufourmantel and Co., the exquisitely beautiful yarns, 360s., shown by Seydouz, Siebert, and Co., the moucheté yarns, beaded yarns, yarns with a thread of cotton twisted

and broken in it, yarns with threads of different colours in an opposite twist on a white roving, and a variety of gold and silver thread yarns shown by various French houses, as also a large assortment of twisted yarns from Verviers and Rheims. Nor, on account of its relation to this district, can notice be omitted of the very beautiful case of silk waste products shown in Class 31 from Halifax by Messrs. Lister and Co.

## Woven Fabrics.

Wool and mixed fabrics.

In all wool and mixed fabrics there is much in the Exhibition of 1867 which is interesting to Bradford. England is represented in Class 29 by Messrs. James Akroyd and Son, Messrs. C. F. Taylor and Co., Messrs. Mitchell and Shepherd, Messrs. Middleton, Answorth, and Co., and one or two others in addition to the Bradford collective exhibition. Perhaps the first thing that fixes the attention is the little effort at

England.

display which England makes, within very little compass, and in cases not so handsome as we understood were ordered. Bradford shows a very complete range of the market goods upon which the trade of the district rests, and from the manner in which they are shown, less regard has evidently been had to the eye of the casual observer than to facility for examination and comparison as a matter of

France.

business. By France, however, just as in 1862, no effort has been spared either in taste of arrangement or profuseness of display; one hundred and ninety-five, or, curiously enough, exactly the same number of exhibitors as in 1862, being catalogued in Class 29, including the collective displays of Rheims, Roubaix, and Tourcoing, the whole being shown with ample space in very handsome cases. In these France clearly maintains her long-established superiority in the finer all-wool plain goods, and this not by the introduction of any special novelty since 1862, but by the cheapness and beauty of the fabrics produced in merinoes, reps, poplins, &c. And it is also equally evident that in mixed Bradford goods, France, though not perhaps approaching us more nearly than she did in some few things that were shown in 1862, yet has made an approach much more general and on a vastly larger scale. On this point, however, it may be said first, that these woven fabrics are exceedingly similar in colouring and design to those of this district: and, secondly, that there is no means of applying the final test of prices, inasmuch as no prices are given that are of any avail in making a comparison. But it must at

the same time be recognised that Roubaix, the Bradford of France, has displayed great energy and skill in competing with goods admitted under the commercial treaty. Indeed, we are informed on good authority that Roubaix has increased her machinery fivefold since 1862. Her success proves in the most striking manner both the advantage of a wholesome competitive stimulus, and her ability to hold her own in her own market without the adventitous aid of a protective duty of 10 per cent. It is difficult to select for remark from so many cases, but we especially noticed the following:—Sautret Pousinet, double merinoes; Bossuat, beaded stuffs; Durand, fancies; Moreau, fabrics of Angora rabbits' wool; Sellier Delaforge, mixed fabrics; Larsonnier frères and Chenest, very splendid prints, both in large and small patterns; Chatteau, fancies; Pin Byart, ditto; Louis Cordonnier, ditto; Delfosses frères, ditto; Leclerq Dupin, heavy Orleans and Alpaca; and in one class of mixed goods, hand made from fine organdzine, silk warp, and mohair weft, with a swivel figure, some very beautiful goods, which Bradford does not attempt to make, were shown in several cases. The report in the French catalogue states that the number of hand-looms employed on worsted goods in France continues to be about the same that it was, and is even yet considerably greater than the number of power-looms, but that the increase of the trade may be measured by the extent to which power-looms have been introduced. That the wages of combing and spinning are generally higher than they were, and that whereas the exports of woollen and worsted goods together were about six millions and a half sterling in 1855, the exports of worsted goods alone exceeded eleven millions sterling in 1865.

Austria, Prussia, &c.

The coloured checks and shawls of Austria, Prussia, and Saxony, and the damasks of Austria, show to great advantage; and with them are exhibited cases of very good fine merinos and some mixed worsted fabrics. An excellent case is shown from Belgium by the Société Anonyme of Loth-les-Bruxelles. The goods shown from Carlsvik in Sweden fully maintain the high position they took in 1862, and are shown in cases combining effective display with great facilities for examination.

Russia.

In Russia, judging from the goods shown, and the number of exhibitors, there is evidence of great skill and progress, and of a considerable extension of the trade having take place. In addition to the cases of Messrs. Armand, of Moscow, and Schepeler, of Riga, which were so interesting in 1862, there are now very

Report on the Worsted Trade.

admirable collections of goods from Messrs. Bordine, Messrs. Bontiguine, Messrs. Elaguine, Messrs. Mikhailoff, Messrs. Schrader, and others, of Moscow; Mr. Krouche, of Warsaw; Schneidemann, of Riga, &c. In these cases a general range of all wool and mixed fabrics may be found, comprising counterparts both of the merinos and poplins of France, and of the cotton warp goods of Bradford, both plain and fancy. In one of these cases, that of Boutiguine, we saw also a very nice range of small China figures. It only remains under this head to notice that Spain, which made no show of these goods in 1862, has bought our looms, and is importing our yarns in addition to spinning herself, and now shows from Barcelona very excellent copies of our Bradford makes.

## Dyeing and Finishing.

Dyeing and finishing.

With regard to dyeing and finishing, although the French, from the fact of their using no oil in the manufacture of their merinoes, are enabled to produce their very light colours beautifully bright and clear; yet we have not seen any superiority in the darker colours of all wool goods over the case shown by Messrs. Ripley and Sons, of Bradford. There is something, however, in the finish of French all-wool goods which adds very greatly to their elasticity and handle. As to the dye and finish of mixed fabrics, the same observations apply as the manufacture of these goods; and there is nothing in the Exhibition superior in these respects to the dye and finish of the goods shown by the Bradford Chamber of Commerce.

## General Remarks.

Conclusion.

Perhaps we may be allowed in conclusion to state the general impression which we received from the Exhibition of 1867 as to the character and progress of the competition which Bradford has to sustain. As has already been mentioned, the exports of yarns and worsted goods from France amounted in 1865 to upwards of 11,000,000*l*., sterling, and of England to upwards of 18,000,000*l*. sterling, the spindles in each country being nearly equal in number. It would be extraordinary if in two trades of such magnitude and long standing, each country had not its special excellence. The superiority of France in fine all-wool plain goods can no longer be attributed to the drawback, as that has ceased; nor entirely to the hand-loom, as they are largely made by power; nor can it now be supposed as it was in 1855, that

the superiority is owing to the use of French-grown wools, as Australian is used for both weft and warp. Something is, no doubt, due to the adaptation of the French system of drawing to spinning by the mule-jenny, and to the circumstance that the English yarns for all-wool goods generally are spun down too much, by which they are said to be rendered less fit for the purpose, and at the same time dearer. Whatever the cause may be, it is a fact that the price of fine all-wool dress goods has been much cheapened, and their importation into this country increased since 1861. Rheims alone has nearly doubled its production of all-wool merinos since 1862, and the all-wool reps and poplins which have been made in other parts of France have secured a remarkable hold on the English market. It cannot, therefore, but be matter of regret that this portion of the trade should be left to our opponents, with so little effort on the part of Bradford to compete, especially seeing the facility with which the growth of wool required is extended, and that the best wool for the purpose comes from our own colonies, and is sold in our own ports.

With regard, however, to mixed fabrics, it is evident that the superiority rests with England, but that they can be made not only in Roubaix, but in Sweden and Russia, and where we should perhaps least expect it, in Spain; and the bearing of this fact is in no way altered by the circumstance of their being made to a great extent on English looms. As to the maintenance of our superiority, therefore, in these goods, it becomes a question, in the first place, of progress in manufacturing skill and taste, and, in the next place, of value. That a brisk trade, such as prevailed in Bradford from 1862 to 1866, wonderfully lessens the motive to improve in either style or fabric, or, in fact, to introduce any novelty, and that a difficult trade operates in a contrary direction is evidently as much felt at Roubaix as at Bradford. The fair view, therefore, to take is that before the commercial treaty Roubaix fell behind from want of competition, and has since been fetching up arrears as a matter of necessity. But we have not discovered anything in the Exhibition to indicate a probability of our being likely to be distanced in mixed Bradford goods as a matter of skill and taste. As a question of value, we have had no means of comparing prices; but on this point the maintenance of a protective duty speaks for itself, and in this respect there need be little fear of a competition that labours under the disadvantage of being overlaid by a protective duty.

REPORT ON THE WORSTED TRADE.

Effect of the French Commercial Treaty.

We annex tables showing the effect of the French Commercial Treaty in very largely extending the worsted trade of that country, and showing that it has led to a large, though not rapidly increasing, importation of Bradford yarn and goods into France, and at the same time to an increased exportation of French worsted goods to England and other countries; the effect being thus a mutual benefit to the manufacturers as well as to the consumers of both France and England. Is it not a fair inference from these facts that it would be a still further benefit to both countries if the remaining 10 per cent. were out of their way? and would not the same result follow from a reduction in the prohibitory tariff of other countries? For instance, the Russian catalogue states that Russia has already twenty-two mills engaged solely in combing and spinning worsted yarn, and imports, in addition, so large a quantity of yarn at a low duty as to employ together 117 mills in weaving worsted yarn, the goods produced being of the annual value of a million and a half sterling. Is it not evident, from the results of the French treaty, that a country with such a trade established as Russia has, and with such skill as she displays at this Exhibition, can need, even for purposes of protection, no such duty as an average of nearly 70 per cent., and that such a duty must equally injure both her customers and her producers.

## TABLE No. 1.

Exports of yarn and worsted goods from Great Britain to France.

The English Board of Trade returns comprise goods in transitu. The French official returns of imports from this country exclude goods in transitu, and are as follows :—

### YARN.

| — | Alpaca. | | | Mohair. | | | Other Yarn. | | | Totals. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ | *s.* | *d.* | £ | *s.* | *d.* | £ | *s.* | *d.* | £ | *s.* | *d.* |
| 1861 | 4,066 | 19 | 0 | 226,384 | 0 | 0 | 24,236 | 19 | 3 | 254,687 | 18 | 3 |
| 1862 | 538 | 16 | 0 | 197,290 | 1 | 7 | 259,036 | 17 | 5 | 456,865 | 15 | 0 |
| 1863 | 119 | 9 | 6 | 173,914 | 0 | 0 | 381,444 | 11 | 2 | 555,478 | 0 | 7 |
| 1864 | — | | | 204,226 | 17 | 5 | 364,570 | 15 | 0 | 568,797 | 12 | 5 |
| 1865 | — | | | 262,681 | 8 | 8 | 271,306 | 19 | 3 | 533,988 | 7 | 11 |
| 1866 | — | | | 280,081 | 15 | 0 | 274,799 | 12 | 0 | 554,881 | 7 | 0 |

WORSTED AND MIXED GOODS FOR THE SAME YEARS 1861–6.

| Merinos. | | | Other All-wool Goods. | | | Mixed Goods. | | | Alpacas. | | | Totals. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| £ | *s.* | *d.* | £ | *s.* | *d.* | £ | *s.* | *d.* | £ | *s.* | *d.* | £ | *s.* | *d.* |
| — | | | 52,004 | 14 | 4 | 486,920 | 12 | 8 | 1,186 | 17 | 5 | 540,112 | 4 | 5 |
| 176 | 10 | 0 | 27,764 | 6 | 4 | 1,095,557 | 0 | 0 | 68,367 | 1 | 7 | 1,191,864 | 17 | 11 |
| 2,769 | 11 | 3 | 19,259 | 4 | 0 | 735,770 | 5 | 6 | 45,718 | 17 | 5 | 803,517 | 18 | 2 |
| — | | | 16.851 | 18 | 5 | 734,064 | 7 | 11 | 80,387 | 4 | 10 | 831,303 | 11 | 2 |
| 6 | 10 | 0 | 18,643 | 3 | 2 | 822,210 | 0 | 0 | 159,153 | 17 | 5 | 1,000,013 | 10 | 7 |
| — | | | 16,326 | 15 | 10 | 1,081,973 | 15 | 10 | 34,201 | 11 | 10 | 1,132,502 | 3 | 6 |

TABLE NO. 2.

Imports of worsted and mixed goods from France into Great Britain. There are comparatively no imports of yarn.

The French official returns comprise goods in transitu to the United States and other countries; they do not therefore show the imports for home consumption in this country, but serve to indicate the stimulus given to French manufactures by the commercial treaty, and are as under:—

| — | Merinos. | | | Other All-wool Goods. | | | Mixed Worsted Goods. | | | Totals. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ | *s.* | *d.* | £ | *s.* | *d.* | £ | *s.* | *d.* | £ | *s.* | *d.* |
| 1861 | 466,015 | 4 | 0 | 752,209 | 12 | 9 | 431,069 | 0 | 9 | 1,649,313 | 17 | 6 |
| 1862 | 823,704 | 8 | 0 | 609,261 | 12 | 9 | 946,638 | 0 | 0 | 2,379,604 | 0 | 9 |
| 1863 | 1,209,236 | 2 | 6 | 783,628 | 18 | 4 | 1,057,801 | 3 | 11 | 3,050,666 | 4 | 9 |
| 1864 | 1,079,694 | 17 | 6 | 1,065,081 | 16 | 9 | 1,236,461 | 19 | 0 | 3,381,238 | 13 | 3 |
| 1865 | 1,443,987 | 0 | 0 | 486,528 | 13 | 7 | 947,666 | 4 | 9 | 2,878,152 | 18 | 4 |
| 1866 | 1,291,719 | 12 | 0 | 928,822 | 12 | 0 | 1,501,985 | 11 | 1 | 3,722,527 | 15 | 1 |

The British returns of goods from France do not comprise goods in transitu; but here a difficulty arises from the classification of so many different articles under the head of woollen manufactures. Omitting, however, four items—viz., carpets and rugs, shawls, scarfs and handkerchiefs, cloths and hosiery—there remain only two items, stuffs and unenumerated articles, and it is obvious that these run into each other, because it will be observed that sometimes one item is larger, sometimes the other; but whenever one is larger the other is less. Probably, therefore, no very serious error will be committed if they are taken unitedly to represent either the absolute or otherwise the proportionate

REPORT ON THE WORSTED TRADE.

amount of goods of Class 29, or Bradford goods imported from France into Great Britain, and are as follows:—

| — | Stuffs. | Unenumerated. | Totals. |
|---|---|---|---|
| 1861 | £474,196 | £180,177 | £654,373 |
| 1862 | 544,794 | 315,889 | 860,683 |
| 1863 | 341,980 | 832,970 | 1,174,950 |
| 1864 | 462,289 | 609,366 | 1,071,655 |
| 1865 | 250,886 | 807,228 | 1,058,114 |
| 1866 | not yet published by the Board of Trade. | | |

## Report on Carded Wool and Woollen Fabrics.—(Class 30.)—By Thomas Nussey, Esq.



Every exhibition gives evidence that with increased population woollen manufacture becomes more and more extended, and more universally adopted for the clothing of both sexes. The increased supply of wool given us by our colonial possessions and the using of second-hand material enable us to meet the great demand with reasonable prices, which are within the grasp of all classes. And we must not forget how much we owe to the application of ever-improving machinery both for manufacturing and finishing, together with the taste for fabrics of a soft and pliable character which so much supersedes the old style of hard milled cloth, and is so much more quickly produced. But in writing a report of woollen manufacture in connection with the Paris Exhibition of 1867 our purpose is not to give an exhaustive history of woollens, nor to show how it flourished in the low countries in early times, nor yet to relate how England has progressed in her woollen manufactures since the Duke of Alva, in 1570, drove over a large number of Flemish refugees, who settled especially in Yorkshire, but to collect in a condensed form what we have considered as the most powerful indications of general improvement, and to compare the productions of one country with another, hoping create an honest rivalry, and thus to benefit the world at large.

The insatiable thirst for novelty has been one means of causing a great impetus to the trade, bringing out new materials and introducing improved mixtures and new and beautiful dyes. The removal of trade restrictions, thus opening new markets, has also brought rapid progress, and no doubt has quickened inventive power which otherwise must have laid dormant.

We shall now proceed to enumerate the different countries represented in this department of the Exhibition, beginning first with France.

### France

shows a most varied and superior description of woollens, and has a collection in every respect worthy of so great a country. She still maintains her position in twist and fancy goods, and in all fancy styles where the minutest

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attention to spinning and twisting is required; her system certainly excels ours, which a slight observation will at once detect.

The figured coatings in silk are beautifully spun and made; also the witneys, sable furs, and Moscow beavers. She stands unrivalled for her remarkable productions in velvet piles and naps, especially adapted for ladies' mantles, they have such a beautiful softness imparted to them by the adoption of M. de Montagnac's invention, which is now so generally used. No doubt this perfection has been the means of woollens becoming a favourite wear for ladies, and thus extending this branch of the trade; the astrakans and fancy rugs are very superior, are well made, and display great taste.

Amongst the novelties is velvet cloth interspersed with glass, opaque, steel and gold beads, and brass shavings; also cloths made from felted yarns, which are commended as being soft, light, and elastic, and at little cost.

The fancy trouserings are in great variety, in quiet good styles of the newest patterns, and are the very best exhibited. In superfine cloths we must say that we have seen France to greater advantage in former exhibitions; there is no improvement in the finish, and French manufacturers can scarcely be said to hold their position in this class of goods. The low fabrics exhibited in Class 91 are remarkably dear, and do not compare with the same description of woollens in the Huddersfield, Dewsbury, and Batley departments. The military cloths are well made, good in colour, and should not be overlooked.

## Holland

Holland.

nas a worthy exhibition of blankets and woollen coverlets; they are thick and soft. There are also some good specimens in fancy coatings, meltons, and broadcloths.

## Belgium.

Belgium.

We find some excellent exhibits in plain and medium cloths, which compare closely with Yorkshire. In superfine cloths she is not so successful, but in heavy overcoatings, as reversible beavers, Moscows, Sataras, deer and doe skins, and other ribbed cloths, she ranks the highest. The figured and worsted coatings are very commendable, more especially the dice patterns. A good deal of shoddy is thrown upon the backs of the heavy coatings, whereby a cheap and serviceable article is produced, and by which Belgium has been enabled greatly to increase her trade. England must

be alive lest in this class of goods she is beaten out of neutral markets.

The fancy trouserings have well-developed patterns, and the same excellence of spinning and twisting is as observable here as in the French department. There is a good display of military cloths, of excellent dye, and well manufactured; the meltons, generally, are not so good; they handle hard, and are not well mixed.

## Austria.

Austria.

This department is not so imposing as the one she had in the London Exhibition of 1862; but the fabrics that are displayed are of general excellence. The trouserings are beautiful both in texture and colour, the shades most delicate, and the patterns are unlike those of any other country, and in remarkably good taste. There is also a good collection of coatings, in which silk is combined with wool, and which have a very neat appearance. The heavy coatings in various makes, such as lambskins and tufted and velvet mantle cloths, are equally successful, are beautifully made and finished, and deserve great praise. The prices, however, run high.

The dyes, for brightness of colour with cleanliness, stand pre-eminent; they cannot be excelled. This is particularly observable in her military cloths; the scarlets, blues, orange, rose, green, and white possess richness and distinctness not equalled by any other country. The finish of the superfine cloths is not good, and is scarcely adapted to the present taste.

## Prussia,

Prussia and North German Confederation.

which includes the Northern States of Germany, Silesia, and the kingdom of Saxony, manufactures a great variety of woollen fabrics, and has an increasing foreign trade. The principal seats of manufacture are Aix-la-Chapelle, Düren, Leppen, and Hückerswagen. They exhibit an assortment of reversible and sable beavers, tricots, Moscow beavers, and witneys, all of which are excellent, taking the medium prices into consideration.

The superfine cloths are of considerable merit; the finish approaches the nearest to that of England, and the dyes generally are very good, especially the blacks and blues. We notice that the hardness which has been characteristic of the German make is partially lost, and they have attained that softness and elasticity which has for so many years been approved of in the London market. They sustain their

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reputation for doeskins, and have some good specimens of coatings, but nothing specially upon which to remark. The trouserings are well made, but the style and patterns bad; they are large and staring.

Görlitz, Silesia, and Liegnitz have a large exhibit of goods made for the Levant and Persian markets; also billiard and low military cloths in good colours. This class of manufacture forms a considerable branch of their trade, and ranks amongst the cheapest and best makes of the kind exhibited. The display that Saxony has is of a good general character; the cloths are well made, but we cannot say the same of the finish; it is too glazey, not a wrought face, and shows too much the effects of the hot press. The plain and fancy flannels, shawls, and woollen materials for underclothing are all commendable, are in great variety, and form an interesting portion of this department.

### Bavaria and Wirtemberg

Bavaria and Wirtemberg.

forward a varied assortment, but it is not of much interest. Their best productions are blankets and rugs.

### Switzerland.

Switzerland.

In this collection we noticed nothing of special importance; and the goods are hung too high for general observation.

### Portugal

Portugal.

exhibits some fair specimens of black and military cloths, also fancy coatings and trouserings of merit.

### Sweden,

Sweden.

a primitive but useful assortment of woollen fabrics of all descriptions. A double lambskin, beautifully made, is worthy of notice.

### Denmark

Denmark.

exhibits a few coarse woollens, adapted for military use.

### Russia

Russia.

has a very creditable display. The broadcloths and fancy coatings are well made and good; the treble overcoatings are among the best exhibited, and vie closely with some of the older manufacturing countries; there are several descriptions of fabrics peculiarly her own; and Russia's improvement and advance in woollens is considerable.

### Italy

shows a good variety of woollens. The fancy coatings and trouserings are in neat styles, and well made. There is a choice assortment of blankets, coverlets, rugs, and military cloths, also of plain satin and billiard cloths. Italy.

### Turkey

exhibits a moderate collection of woollens, chiefly adapted for her own consumption, manufactured from wool and camel's hair mixed. The colours are quite of an Oriental cast. Turkey.

### Great Britain,

as a whole, exhibits the best superfine cloths. The west of England has long had a reputation for her superiority in this class of woollens, also for kerseymeres, doeskins, and beavers, and she still maintains her position. She has some advantage in the purity of the water, which greatly assists her in the dyes of scarlet and colours suitable for billiard and livery cloths. The medley cloths are very good; the quiet, neat styles of the coatings denote excellent taste. There is nothing of this class of manufacture superior in the Exhibition or more deserving of praise. England.

Huddersfield and its vicinity is one of the most important seats of the woollen manufacture, and exhibits, both for make and design, a varied and excellent assortment of trouserings, coatings, vestings, mohairs, Bedford cords, velvet piles, rugs in imitation of skins, and novelties in ladies' mantles. These productions, with their reasonable prices, are unequalled, and bear evidence that the manufacturers are alive to every improvement. Huddersfield is unrepresented by her best makers of broadcloths, Devon beavers, and doeskins, a fact to be regretted, as she holds a good position in this class of fabrics. Huddersfield.

Leeds and the neighbourhood, although the oldest and most important district in England for woollens, has, unfortunately, contributed so little to the Paris Exhibition that strangers interested in this manufacture can have no idea, from what they see, of the large, varied, and extensive trade carried on in this part of Yorkshire; and, this report being confined to goods that are to be found exhibited, Leeds has scarcely done herself justice in allowing such a leading manufacture to be thus overlooked. There are simply a few broadcloths, beavers, meltons, and fancies; they are well done, the meltons especially so. Leeds.

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Morley. The cotton-warp cloths exhibited by Morley are unequalled for general excellence in make, finish, and cheapness; her display does her much credit; they are all well made, well finished, and handsome goods, at low prices.

Batley and Dewsbury. Batley and Dewsbury know no rival for their productions in heavy goods, as reversible beavers, witneys, furs, pilots, cheviots, fancy rugs, and low army cloths. The fabrics produced in these districts are chiefly made in cotton warps; the difficulties formerly experienced in dyeing the warps have been overcome, and such perfection in this has been now attained that none but an experienced eye can detect any difference between them and those made entirely of wool. The exceeding lowness of price, combined with excellence, may easily account for the large and flourishing trade which these towns continue to enjoy. These, with the Morley exhibits, will, it is to be hoped, help to remove Continental prejudice with respect to cotton warps; they certainly are very superior to the low goods made from all wool exhibited by other countries; indeed, Morley, Batley, and Dewsbury do more towards clothing the million in woollens than any other part of the globe.

Heckmondwike. Heckmondwike has a good assortment of blankets, rugs, and carpets.

Scotland. Scotland is represented by only a few manufacturers, but these exhibit a varied collection of trouserings, shawls, and fabrics of a soft and beautiful character. Their rank in the woollen trade is high, and their trade extensive, so that it is to be regretted that the position they hold is not better sustained here.

Ireland. Ireland has some good specimens of tweeds, trouserings, and friezes equal to any shown in this particular class. Having done so well, it is difficult to see why she should not greatly extend this manufacture. Her want of coal is certainly an obstacle, but this has not prevented her linen manufacturers from making steady progress, and equal energy and skill would, if applied, no doubt result in considerable advancement in the manufacture of woollens.

Conclusion. Before closing this report, it may be desirable to institute a comparison between this and preceding exhibitions, with

Progress of woollen manufacture. a view to giving some idea of the progress of the woollen manufacture generally. It will be readily understood that this manufacture does not afford much scope for artistic design; nevertheless, it gives opportunity for the exhibition of taste or skill in the assortment of colour, in texture, and in finish. It is evident that any improvement in this

manufacture cannot be of so striking a character as in some other branches. One of the most marked and striking improvements is in cloths for ladies' mantles. The French have paid great attention to the manufacture of articles for this purpose. The Germans also, as we have previously stated, have shown some excellent goods of this kind. The Huddersfield manufacturers have also exhibited goods of great beauty. The variety of patterns is very great, and as compared with former exhibitions there is a great improvement visible in every respect, whether in design, colouring, or make.

Cloths.

In fine plain cloths no great change is apparent, nor can much be expected, as this manufacture has long attained a great degree of perfection. The fine cloths are exceedingly good, and those of the west of England are, beyond doubt, the best exhibited, and are better than have ever been shown before. The Prussian cloths are the next in point of merit, and very good samples are shown by Belgium. In medium low cloths the Belgians are the best. Leeds, the centre of this trade in England, only exhibits two or three specimens; but judging from these, Leeds would, had she contributed more largely in this article, have held a decidedly good position in them. For some years past there have been made in the Leeds district, especially in the village of Morley, large quantities of plain and coloured cloths, with cotton instead of woollen warps. By this means a very handsome and useful cloth can be made at a very low price, and the exhibition of them is very good. They were extensively exhibited by Leeds at the Exhibition of 1862, and the improvement in the manufacture of this kind of cloth since that date is manifest.

In heavy coatings there is not much change so far as respects the make of the cloth, but the styles are generally much neater and in better taste, and France, Belgium, Austria, Prussia, Russia, and Great Britain each make a very good show of them; some from Austria and Russia are remarkably stout and heavy. A class of goods of this description is shown from Dewsbury and Batley, near Leeds, which merits notice. They are of cotton warp, and with the wool is used a portion more or less considerable of shoddy. Much objection is taken to the use of shoddy in cloths, but when judiciously and moderately used the cloth is nearly as good as if made from all wool, whilst much cheaper, and with a better appearance, and thereby brought within the means of classes who could not otherwise afford to buy it. In this branch none of the goods exhibited by

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other countries at all approach those made in Yorkshire, especially if the cost is taken into consideration.

In fancy trouserings there is a decided improvement in all respects since 1862. The goods generally are better made, and the designs in better taste. In fine qualities the French and Belgians excel, and the goods give evidence of great care and attention to every detail in the manufacture. The spinning is admirable, as is also the twisting, and it is evident that every minute point is strictly attended to The consequence is that they show a greater degree of perfection in the manufacture than any other. Each point may in itself be of little importance, but when combined they make a very perceptible difference in the result. The attention of British manufacturers should be given to this subject. It is probable that this minute care may to some extent increase the labour, and therefore the cost, and it, no doubt, does so; but this, if not too great, is not of such material consequence in fine goods. There is nothing to prevent the British manufacturers equalling the French and Belgians in this respect as in any other; but unless more attention is given to these details, Great Britain will have difficulty in maintaining her position as a manufacturer of fine trouserings.

Felted yarns.

Attention has been drawn to the use of felted yarns by the French manufacturers. This is a comparatively new feature in the woollen trade, and excellent use has been made of it in the manufacture of cloths for ladies' mantles. So far as we know it is not used in Britain, but it is desirable that her manufacturers should examine into its merits.

In dealing with any great branch of manufacture it is natural that attention should more particularly be given to those productions which show the most beauty and evidence the greatest skill; but there are others which, having less pretension to either of these qualities, are still of great importance; and these are the fabrics made for the million. In these lowness of price is of paramount importance; and they will not, therefore, bear any unnecessary expense in the manufacture. By utilising material which was formerly cast away as waste great progress has of late years been made in the production of cheap cloths. No country exhibits articles of this description which will bear comparison with those from England.

Technical education.

There can be no doubt that the French, Belgian, and Prussian manufacturers are greatly indebted for their progress in this and many other industries to the very superior

technical education which their manufacturers and workmen obtain, by means of the schools instituted for special instruction, not only in design, but in everything which has any relation to each particular manufacture. Without education we cannot expect to have skilled workmen of the highest class, and to a fair general education must be added a special training under good masters in every branch of trade. The adoption of similar schools in Britain will before long become a necessity, and the sooner they are established the better.



In most European States the tariffs have within a few years been revised, and the duties on goods generally reduced. This has introduced into such countries a foreign competition which did not previously exist. It has acted as a stimulus to their manufacturers, and has produced a considerable effect. With our present fiscal system the British manufacturer cannot further be subjected to a similar stimulus to force him to press forward in the course of progressive improvement; but, if he wishes to maintain his position, he must spontaneously avail himself of every improvement adopted by others; and in a careful examination of the goods exhibited here by other countries he will find many things which will give him valuable hints for his guidance.

Tariffs and duties.

## Report on Carded Wool, Woollen Yarns, and Woollen Fabrics.—(Class 30.)—By George Leach, Esq.



"Carded wool."

Carded Wool, though occupying a prominent place in the classification of the British catalogue of Class 30, does not appear to have been introduced into the Exhibition as an object of competition for reward. It rarely forms a marketable commodity, except in the shape of carded waste, shoddy, or extract wool (a product obtained by the chemical separation or reclamation of wool from rags containing cotton and wool).

The term itself, "carded wool," however, embraces the whole of Class 30, and the writer, rather than attempt the compilation of an abridged catalogue, proposes to consider the whole class as one general subject, in the exhibits of which the product of carded wool, of necessity, constitutes the germ of the excellences or defects there to be met with.

At the time of inspection only one specimen of carded wool was to be found accompanying the cloth which it composed. This, though interesting, was yet so single and limited in quantity as to admit of no comparison, where comparison is so very desirable; nor does it merit any special remark, beyond being suggestive for future exhibitions; for nothing could be more instructive to the uninitiated, and certainly nothing more useful or interesting to the practical manufacturer, than that some of the leading descriptions of goods in this great branch of industry should be accompanied by a complete arrangement of the material, in the various stages of manufacture, out of which the finished fabric itself is ultimately produced.

Diversity in method of working woollen carding machines.

In this case, first of all in importance would be carded wool, for it is very remarkable that not only is this process carried on in the principal centres of the woollen trade by machinery of very varied and different construction, but where there is a similarity of machine according to the fashion or habit which has become generally practised in the respective districts, so the modes of working or regulating these machines are also equally different. In fact, so opposite are the "notions" (and the term is used advisedly in contradistinction to the word "principle") of the various workmen in carding wool, that it becomes a most important question to consider which are right and which wrong. To explain, however, more fully, it may be said that a fore-

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man or skilled workman from the Leeds district would utterly fail in his management of a certain given "blend" of wool if he were to take charge of the same upon Belgian, French, or even West of England cards and carding machines, whilst, *vice versâ*, the French workman would be equally perplexed and as little successful with the same wool upon corresponding apparatus common to the Yorkshire district. Thus, in reviewing the exhibits in Class 30, it becomes necessary to consider how far this important operation has been instrumental in producing the distinctive features observable in both carded wool, yarn, and cloth. It cannot be contradicted that deficient machinery or management, in the preceding as well as the succeeding processes, may defeat the result good carding would otherwise produce; but there is no other stage in which an error or deficiency may not more easily be detected and remedied.

Carded wool in process.

But now to the examination of the matter of carded wool itself, to find which we must proceed to the department of machinery in motion; and by preference, and in the order of merit, first to that exhibited by Belgium.

Superiority and carding of Buenos Ayres wool in Belgium.

Here we find an admirable specimen of carded wool, undyed, in "sliver," produced by Celestin Martin, of Verviers, and, though the product of "greasy," "burry," "Buenos Ayres" wool, is highly commendable for "cleanness," "clearness," and freedom from "nibs," "bits," or extraneous matter. Fortunately for our practical British manufacturer (and it is to be hoped also for many of our most intelligent and *unprejudiced* artisans who may visit the Exhibition), M. Martin not only shows such good results, but also the whole process by which they are attained.

Limited area of card employed.

Upon three comparatively narrow and small diameter single-cylinder machines M. Martin produces an effect which would tax the efforts of many of our Yorkshire foremen to perform upon *six* cylinders (besides "breasts") and *three times* the surface of "cards."

Economical results in Belgium.

The "condensed sliver" is like a smoothly drawn wire for evenness, and the regularity with which the fibres are laid is certain to ensure a correspondingly regular yarn. The oil used for lubricating the wool is "oleine" (a fine class of Price's patent cloth oil), distributed by machinery, whilst, in one and the same process, the wool is passing through and being prepared or opened in the "brisoir," or "plucker." The importance of the equal lubrication of every lock of wool before being presented to the action of the carding machine cannot be overvalued; and the infinitesimal division of the liquid, resembling

spray, which M. Martin diffuses amidst his uncarded locks of willowed wool, cannot fail to considerably diminish the work the cards have subsequently to perform and contribute towards that faultless specimen of carded wool of which this enterprising spinner and machinist may justly be proud. And yet, as an element of cheapness of production, it is questionable whether the weight of 120 lb. per day of sliver (from a 44 in. wide machine of so limited card area), of the length obtained and with the same excellent properties, is approached or excelled in all Britain.

It would be very interesting if, during the Exhibition, M. Martin would upon the same machines produce for inspection of future visitors examples of carded wool, dyed in the wool, and also mixtures of colours; yet we have sufficient evidence of the ability of these clever Belgian carders and spinners in the exhibits of yarns and cloths to prove how thoroughly they are experienced in this important art.

There are other specimens of carded wool, in sliver and yarn, in process of being spun, in the French department; but though both these and the machinery, as examples, are very creditable, and deserving attention, the production of M. Martin is so perfect, and the completeness of his arrangements leave so little to be desired, that we must allow the catalogue to indicate and mention by name the other exhibitors, and pass on to the English department.

Here, alas! we see a crowded space, and yet a lamentable void.

Incompleteness of British carding operations in Exhibition.

Our most extensive and incomparable machinists, Platt Brothers & Co., draw their supply of carded wool in the "condensed sliver," from ————, their clients in Belgium! with which to illustrate the working of their self-acting mule. Want of space prevented their showing a complete process and assortment of machines for carding. We are consequently debarred the satisfaction of seeing the production of carded wool upon our most modern models of machinery. Mr. Ferabee, in connection with Mr. John Tatham, of Rochdale, shows wool in the carded and condensed sliver, fed by an admirable and much required "bat feeding machine;" but, since he, too, receives his supplies of half-carded and oiled wool from a distance (West of England), and a strong draught of wind in that portion of the building disturbs the light and fleecy feed his apparatus so perfectly and ingeniously produces, it would be unfair to compare his carded wool with any other. The same may be said of that of Mr. Lister, of Dursley.

Mr. Leach on Carded Wool, &c.

For the sake of instituting a fair comparison, whether the conclusions were either for or against (and in the event of the former being established, for the further encouragement and satisfaction of our own manufacturers; and in case of the latter, as an instigation to increased emulation and effort), it is much to be regretted that the British had not an equally complete assortment of machinery to enter into fair rivalry and competition with the continental manufacturers in the production of carded wool.

Carded woollen yarns.

Proceeding to the examination of "carded woollen yarns" we find Belgium, as in carded wool, the chief exhibitor.

The quantity and quality of yarns exposed in galerie 4 form a suitable introduction to the court where the finished fabrics are exhibited, and prove the importance with which the Belgians regard this branch of their thriving commerce. Nor can it escape attention and comparison that whilst our spinners of hosiery and flannel yarns in two or three isolated instances are the only British exhibitors who have deemed it advisable to bring their productions before the eye of the world the Belgians, the Prussians and Austrians, and the French (in one special novelty) have not merely shown a spirit of emulation in this division of Class 30, but have had the pride and ingenuity to render their display not merely useful and interesting, but attractive and ornamental.

Successful competition of carded woollen yarns by foreigners in Britain.

In paragraph 5 of the general introduction to the British catalogue upon Class 30 is given a list of amounts of woollen and worsted yarns imported into the United Kingdom during the years 1861–5. In 1864 the amount of 4,654,000 lbs. figured as an item of competition against our British spinners, and although there is no means of obtaining reliable or authentic statistical information, yet from the knowledge we have of the extensive and intimate connexion which numerous Belgian, German, and French spinners have for years maintained in Scotland, and the fact of the large carrying trade in yarns which has existed between the ports of Antwerp and Hull and other ports, it may be safely concluded that by far the largest proportion of this considerable importation consisted of carded woollen and angola yarns successfully and profitably produced by our Belgian competitors.

For further corroboration of this conclusion, we may read the advertisements in the Prussian catalogue, and notice those well-filled and well-arranged cases of M. Bouvoisin Fils, Henri Lieutenant, Peltzer et Fils, Henry Leusch, Hauzeur Gérard Fils, Xhoffray et Laoureux (formerly Xhoffray Bruls), all familiar names in the Glasgow

and Paisley yarn markets. Let us also inspect the important collections brought together by the Prussians and the Austrians, especially those by G. Pastor, of Aix-la-Chapelle; Facilides und Wiede, of Plauen, Saxony; and Teuber Jos. and Söhne, of Brünn; and then, surely, we must be impressed with the great spirit of enterprise and superior intelligence abroad which has enabled these foreign spinners to prosecute so undesirable a competition in our very midst.

Perfection of carding and spinning on the Continent.

There will be found among the exhibits by the above-mentioned firms specimens of almost marvellous carding and spinning, both as regards quality, character, and length; and in some cases tickets being attached to the samples of yarns upon which are denoted, in English, the descriptions and qualities in English hanks (worsted count), clearly prove the nationality of the customers whose notice and interest these yarns were intended to invite.

Standard lengths of yarns.

In addition, however, to this, the lengths are generally given in metres per kilogramme, whether the exhibits are French, Belgian, or German; and it is much to be wished that, instead of the dozen different denominations (in fact, varying almost with every locality) by which in Britain the lengths of yarn are understood, we, like our neighours, had one common standard.

Cause of superiority of foreign productions.

Is an explanation asked of the reason of the excellence of these yarns, the reader is referred to remarks upon carded wool. The early adoption of "condensers" and the careful system of feeding the intermediate "carders" practised abroad have also contributed to this result.

Yarn composed of shoddy and wool by foreign spinners.

Special attention must be called to an exhibit of yarn composed of "shoddy" or "mungo" and wool, by Leidenfrost, Eduard, and Söhne, of Brünn, in the Austrian department. Not that there is noteworthy merit in the yarn itself beyond affording evidence of attention being bestowed upon an article which hitherto has almost remained exclusively the specialty of certain of our Yorkshire districts. But unless vigilance be exercised who can predict how short an interval may intervene between the present imagined security of position and that period when the Austrian spinners of shoddy may, like the Belgians, challenge us with and maintain a successful competition in our own market?

Yarn felted, not spun.

Of novelties in yarns, those produced by the inventive genius and indomitable perseverance of F. Vouillon, of Louviers, most claim attention. Instead of being spun in the ordinary manner, these yarns are "felted."

Mr. Leach on Carded Wool, &c.

In the French division of Class 30 (No. 36, French catalogue) will be found exhibits of this new process, in both yarn, and woven, and finished fabrics. A still better display of felted cloth is exhibited in a case in Class 29, by Sabran et Jessé, near which also is a more complete assortment of "felted" yarn. It is not within the province of this report to describe the now successful machinery by which these yarns (without the means of a spindle) are produced; it may however be briefly stated, that attached to a condenser is an apparatus which receives the frail sliver, and by means of heat and friction transforms it into a weavable yarn or thread.

Economy of felted yarn process.

What, however, is of further importance in the economy of the woollen manufacture is the small space this machine occupies—not exceeding that of a single-cylinder carder.

Probable importance of felted yarns.

In this process lies a principle the importance of which it is impossible to foresee. It is not supposed that it will supersede spinning, but it is highly probable that "felted yarns" may be introduced with singular advantage into numerous descriptions of woollen fabrics—such, for instance, as ladies' mantles, cloakings, coverlets, wrappers, or any other class where warmth and lightness are required. In the London Exhibition of 1862 it was shown that felted yarns, and union cloth made therefrom, containing 60 per cent. of shoddy, could be produced by this process.

Character of felted yarn.

The chief characteristics of this yarn are its extreme lightness compared with its bulk, and also that the finer fibres are worked up and laid on the exterior of the thread. The wool, in fact, is united in a more regular mass without the internal hard-twisted "core" of fibres necessary for the adhesion of a yarn spun in the ordinary way. It is also remarkably round and even, and although it is doubtful whether the same length of yarn, or even equal strength, may be obtained as by spinning, yet it possesses sufficient tenacity to admit of being woven into a fabric to which can be imparted any required strength in the subsequent ordinary "fulling-machines, or stocks."

Fancy yarns.

The same inventor's samples of so-called "*moucheté*" yarns receive some attention. These are formed by small lengths of "slivers" of a contrasting colour, or mixture, being detached at equal distances and twisted with the yarn forming the foundation; but these yarns, like the introduction of "pearls," "beads," "brass or metal shavings or turnings," and also yarns with "twisted knobs or knots" ("gezwirnte noppen") found in the Prussian department, involve no important principle of manufacture, but, like many other

vagaries of fashion, will pass away without remembrance or regret.

Mr. Leach on Carded Wool, &c.

"Carded woollen fabrics" form the most numerous exhibits in this class; it is consequently impossible within the limits of this report to do more than point out generally those objects which are either most meritorious or require consideration on the part of the practical manufacturer or the trade. Undoubtedly, the chief advantage conferred by these international exhibitions is the opportunity they afford, not so much for self-laudation, or even satisfaction, as for the examination of those products wherein our competitors, either at home or abroad, approach or surpass us in excellence. It is further desirable, as proposed at the commencement of our investigation of this class, to endeavour to trace effect to cause, or, in other words, to discover, if practicable, the reason of either our superiority or defeat; and as in such an intricate subject much difference of opinion must exist, the writer of this report ventures his own with all deference to that of others.

Carded woollen fabrics.

First in importance, and that also which affords the greatest opportunity for comparison, is that staple article of our woollen trade, plain black cloth. Taking the highest quality first, it is a pleasurable duty to have to report that in the whole Exhibition there are no specimens possessing such general and surpassing excellence as the "superfine wool-dyed black and blue broads" from Stroud. It is difficult to determine which cloth in the collection of Class 30 contains the finest quality of wool; nor is this a matter of much importance, nor deserving of special praise; but, without doubt, to the practised touch no cloth is so soft and so mellow as this. The richest dye, most evenly-dressed face—bright and fresh, yet with a complete absence of that "baked" and lustrous glare (so cheaply obtained on the Continent by "decatting" with high-pressure steam)—elasticity of texture: all these qualities are combined in the happiest, most apparent, and successful manner. In short, this is "broadcloth" *par excellence*.

Broadcloth. West of England, superior.

The Continental makers also show some wonderful examples of fine cloth; but, though Bischoff, of Aix-la-Chapelle; Grossmann and Söhne, of Bichofswerda (Saxony); Schœller, of Düren; Schœller Gebrüder, of Brün; Simonis, of Verviers; Chatten, of Disen, and others from Sedan, are well forward in the race, the palm must be given to the exhibitors from Stroud, who have so worthily maintained the prestige of their district, and thus saved our national reputation as the first and best makers of "superfine broadcloth."

Continental exhibitors of broadcloth.

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Absence of exhibits from Yorkshire.

Of medium qualities (plain cloths), so little is exhibited from the Yorkshire district, that not only is there no opportunity of comparing foreign exhibits with our own, but the stranger and those uninformed might acquire the idea that our trade in this article had completely died out. It may be observed, however, that there are frequent indications amongst the Continental exhibits of an increasing taste for a quieter, less glossy style of finish, and that there are some admirable examples of very excellently made plain cloths in both piece and wool dyes.

Old "Billey" process in England.

In competing for this, really the most important and most universal branch of the woollen cloth trade, those of our manufacturers who adhere to the old "Billey" process may with profit bestow a consideration upon the example long set them abroad of adopting the "condenser" entirely.

Cloths with cotton warp. Excellent and superior English exhibits.

Plain union cloths, although not largely exhibited, are worthily represented by Morley manufacturers. Class 91, in Group X, was searched in vain to find anything worthy of comparison with these goods; and it is to be hoped that the wonderful perfection and the extreme and surprising cheapness of these fabrics will attract the attention of our French neighbours interested in this class, obtain from them a due appreciation of their merits, and thus stimulate a demand for these cloths amongst that large portion of the population of France hitherto clad in the "less viewly blouse."

Cheap clothing from England.

In heavy goods for winter clothing of better qualities, especially in "Moscow beavers" and reversibles, the necessities of the Continental climate, together with a complete mastery over their art in working pure wool, have enabled the Prussians and Belgians to outstrip all rivals and imitators. To be convinced of this, we need only inspect the productions of J. B. Schœller, of Düren (Prussia), and A. and F. Drèze, of Dison (Belgium).

If we wish, however, to judge whence to draw supplies of warm, heavy, cheap clothing for the million or for army use, we need only turn to the exhibits of the Batley Chamber of Commerce, and we shall again at once be convinced that for goods requiring mixtures of "artificial wool," "shoddy," "mungo," "extract," &c., in order to reduce the cost, and still affording a substantial and wearable article, England stands without a rival.

The same may be said in reference to flannels, blankets, and soft-spun woollens; not omitting the mention of railway rugs and horse clothing.

Fancy woollens.

Of "fancy woollen fabrics" there is an enormous and most varied display. A most heterogeneous mass; and, as leaves

on every tree differ in shape or substance, so does the result of "fancy" here bewilder with its multiplicity. To make *one sweeping comment*, and insist that this particular country or district displays the best taste, would be as ill-considered as it would be unfair. Peculiarity of climate, customs, and education must naturally influence this; so that, without equal experience and complete exemption from patriotic prejudices (which is next to an impossibility), it is undesirable to pass judgment or come to any conclusion on this subject. MR. LEACH ON CARDED WOOL, &C.

Weight, strength, quality, substance, closeness or fineness of texture, and length of spinning, may all be measured and compared; and we regret to say that, judging from what is exhibited *in the building only*, we must concede to our foreign competitors the preponderance of merit. Foreign excellence.

In the particular class requiring fine spinning the race is very even between the French, Belgians, and Germans; but, for examples, may be specially mentioned goods by Auspitz, Max Bum, and Latzko, of Brünn; also by Hulin et Paquin, of Sedan; Simonis, of Verviers, and Schœller, of Düren. Here there must be the very perfection of carding and spinning before such goods can be produced. Our Scotch, Huddersfield, and West of England manufactures are well represented by excellent specimens; but here the West shows indications of more careful carding and spinning.

An exhibit of well made cheap tweeds, in good colourings, from Cork is a praiseworthy contribution from Ireland. Irish tweeds.

In mantle cloths or articles for women's clothing France makes the best display, exhibits the greatest novelties and most costly qualities. Austria has also some attractive specimens. In this department there is a great prevalence of "velvet pile" or plushed face, which, in articles composed of vicuna or mohair wool, imparts a peculiar softness. This process of "plushing" or velveting seems thoroughly to be understood by the French, and is largely introduced into trouserings.

Holland exhibits superior blankets, and very fair black cloths; but since we have passed in review the productions of those countries from which we may derive interest or information, we must pass over those of Russia and the remaining German States, Denmark, and Spain without further comment.

This report on Class 30 cannot be concluded without a candid admission that (judging from the actual specimens in the Exhibition, and from the general impressions formed), our Continental competitors offer much for our consideration; and especially do we note numerous proofs of a superiority Superiority of system of carding pure wool on the Continent.

Mr. Leach on Carded Wool, &c.

in the process of carding. Let it, however, be well understood that the foregoing remark applies more especially to the treatment of pure wool only in the north of England (even to the exception of the West of England, where a system of carding is carried on almost identical with that of our foreign competitors); but, whilst we have the satisfaction of knowing that our home and Yorkshire manufacturers possess the "knack" of dealing with those blends of wool and shoddy, and extensive though the scope is for our manufacture of "woollen fabrics" of inferior or medium qualities, is it not a desirable subject for study and ambition to obtain and secure a fair share of the enormous demand there is abroad for the finer descriptions of goods?

"Rest and be thankful" notions.

Many warnings are undoubtedly given to us in this World's Fair. Let us take heed, therefore, that though we are fortunate in producing beyond present rivalry the cheaper articles of clothing, we are not overtaken in our "luck" and experience, or outstripped on the very ground upon which it is evident we have lost so much of our trade in fine goods. If an enumeration of these causes be requested, we suggest the following questions which occur now to those who visit this Exhibition of 1867:—Who first turned their attention to more careful wool scouring and washing? Who retained truth in their carding-engines by reason of not unduly extending their width, to gain quantity at the expense of quality? Who have adopted first iron or other non-expanding or warping covers for cylinders or doffers? Who have adopted improved fixings of these machines whilst our "overlookers" have been "tapping," or rapping their worker shaft ends to make them bed in their clumsy, loose, ill-fitting bearings? Who further adopted the "condenser" when the blood of our "pieceners'" fingers was lubricating the clumsy over lap-joints of the "cardings" in our antiquated slobbing process? Who were spinning away upon Platt's self-actor mules, ten years or more ago, whilst we were hesitating and ordering "hand-mules"? and, lastly, though not the least, who invented and adopted the "milling machine"? This is not a flattering picture to draw. Not many years ago these were "new-fangled notions." What are they now? and is there not reason to profit by past experience?

"Labour."

Our woollen trade is, undoubtedly, not keeping pace with our rivals', and the sooner we know it, discover the reason, and act accordingly, the better. But, whilst the foregoing remarks imply a reflection upon our sagacity as *master manufacturers* and employers of labour, the subject would

be incomplete without also inquiring whether the character or quality of the labour itself has or has not impeded the progress of the trade. We have the most enduring, able-bodied workpeople, and it would be a libel to deny them the possession of the virtue of industry, and though their labour is *nominally dearer* than on the Continent, it is very questionable whether their physical energy or effort would not, under an improved condition of mental culture, counterbalance the disparity. Unfortunately, however, at present their prejudices are as strong as their sinews, and since the knowledge of the art they perform is acquired and practised, more by rote or habit and faith, than by conviction, or an intelligent appreciation of either science or its principles, much unnecessary toil is undergone, much experience repeated which would otherwise be avoided. As a body, our operatives abhor innovations, and their reluctance to accept either improved system or machinery is incredible, and yet do they inherit a deeply rooted belief that our woollen trade is in advance, and that we have nothing to learn from foreigners. The trade is also fettered by clumsy denominations or definitions of weights, lengths, and measures, and we are delayed and inconvenienced by ugly and tedious arithmetic, whilst our competitors, in the main, have universal and decimalised standard measures.

In this we cannot help ourselves; but it behoves our Chambers of Commerce, if they have any vigour or influence and are not merely conducted as pleasing hobbies, or those who can and must help us—our Imperial Government—to be on the alert and change these things, that we may be spared the loss and disgrace of occupying the second place in this the most universal, as it is the most important, branch of industry which has for its object the clothing of mankind.

## REPORT on SILK MANUFACTURES, SHAWLS, LACE and EMBROIDERY, HOSIERY, CLOTHING for both SEXES, and DRESS in different COUNTRIES.—(Classes, 31, 32, 33, 34, 35, and 92.)—By Professor LEONE LEVI, LL.D.

Paris and Universal Exhibitions.

IT is not without reason that high expectations have been formed of the Universal Exhibition of 1867. Conspicuous for her position in the very heart of Europe, sumptuous in her palaces and galleries, and rich in every mark of high civilisation, Paris, the great metropolis of art and fashion, is supremely fitted for the holding of great international exhibitions, which are at once high festivals of industry and great tournaments of industrial nations. We might have expected, from the intelligence which distinguishes our neighbours, that when, for the fourth time, invitations were issued to the industrial world to come forth to the great arena of peaceful competition, a newer and fresher vigour would be imparted to the undertaking, and that, together with the purely industrial elements, much would be done to further the artistic and intellectual, the economic and moral, interests of mankind; but, more especially, it was natural to anticipate from a nation so renowned for her skill in the art of display that, both in the collective view presented of human industry and in every department and section of the same, the general arrangement would manifest, not only a perfect unity of design, but that high regard to order and ornamentation which render such displays scenes of great brilliancy and beauty, and constitute them magnificent schools of public taste, highly instructive and interesting even to the most cursory visitors. Nor have we been disappointed in such expectations. The tenth group, consisting of objects exhibited with a view to ameliorate the physical and moral condition of the people, is a decided addition to previous exhibitions. The systematic collocation of all articles belonging to each class in continuous circular lines, without losing the distribution by countries, is a novelty; and though, in respect of scenic effect, the exhibition may seem somewhat defective, great is the facility thereby afforded for comparing the relative advance of each country in any distinct branch of industry.

The art of display.

At such exhibitions, and in this especially, do we see that, if art and taste can do much to commend those articles which are principally adapted for use and comfort, and whose merits

Prof. Leone Levi, LL.D., on Silk Manufactures, &c.

chiefly consist in their cheapness and adaptability to the varied wants of mankind, still more do they accomplish in imparting grace and attractiveness to articles of luxury and finery. The more precious the jewel, the greater the need of the finest setting to bring out all its brilliancy and beauty. The richness of the material, the brilliancy of colour, and the splendid design, seem to acquire a fresh and surprising charm when the objects are exhibited with exquisite taste and with high regard to artistic effect, as we have seen them along the courts and avenues of the great Industrial Palace, side by side, with the choicest products in every branch of human industry. In this respect, indeed, Paris itself is a great school. Visit those emporiums of rarities at the Boulevards and the Palais Royal. See how elegantly are they arranged! What care and what precision are exhibited in the minutest details! Is it too much to say that articles so displayed not only more readily arrest the passers-by, but succeed in commanding a higher price than their intrinsic value would otherwise realize?

Classes in the group "Vêtements" reported upon.

The classes upon which I have been desired to report form a part of the fourth group, "Vêtements," comprising tissues and objects worn on the person. The articles included in them are varied and attractive. First, is silk in all its beauty; next, shawls, from the splendid cashmere to the finest lace; next, hosiery in all its branches; after this, embroidery, with gold and silver, and trimming of every possible description; and then, articles of clothing for both sexes, in combination with the specimens of the popular costumes of different countries, which meet us at every corner of the Exhibition. A careful examination of such articles is indeed most suggestive; and, if I am not mistaken, they present some aspects of manufacturing industry which bring out very prominently the relative aptitude of the manufacturing countries of Europe to supply the great wants of mankind in all articles of clothing.

British supremacy in articles of clothing.

Taken as a whole, clothing is just the department in which Britain has long claimed to possess a decided supremacy. It is not a vain assumption to say that, by the invention of mechanical contrivances and the discovery of the great motor steam power, the British manufacturer was enabled not only to multiply the production of textile materials to an almost unlimited extent, and to leave hand-work of every description far behind, but to outstep the manufacturing industry of every country. The cotton of India and America, the wool of Africa, the silk of China and Italy, crossed mountains and oceans to undergo, in our shores, the mechanical processes of the spindle and the loom; and, by their cheapness and excellence, British goods became

adapted to the wants of nations of every race and clime, and of low and high civilisation, to the decided benefit of the whole human family. For a time the British manufacturer enjoyed an almost exclusive monopoly of such powers; and, so long as other countries were ignorant of such inventions, and, either suffering from internal discords or involved in the ravages of war, had neither the power nor the will to enter into the path of industry, Britain had no competition to meet. But the world does not stand still. With a long period of peace Europe has learned the value of the peaceful arts. Inventions spread. The seeds of ancient industry sown amidst happier times, but long neglected, have been nurtured and made more prolific. Art and design have been rendered auxiliaries to labour; and, whilst it seemed the special province of Britain to attend to the production of what is adapted to the masses, France and other nations gave themselves more especially to provide for the opulent and higher classes of society. Nor did it end there. The boundaries of national industry are, however, not marked by compact or understanding; and just as Britain is capable of producing and does produce works of the highest art, so France and Germany are showing their power to produce what is cheap and useful.

State of the silk manufacture.

For the study of the silk manufacture no moment could be more opportune. For years past we have seen how much the disease in the silkworm has impaired the productiveness of some of the oldest silk-manufacturing countries. In France the injury resulting from it has been so great that it is even now seriously contemplated to adopt, as regards this disease, the same remedies as in the case of the cattle plague. On the other hand, the silks of China, Japan, India, and Siam have come largely into use, and have effected a complete revolution in the imports of the raw material. Then, again, the treaty of commerce between Great Britain and France of 1860-1, which put an end to the last shred of protection in the United Kingdom and greatly liberalised the tariff of France, now may be said to bear proper fruit; and it becomes interesting to see how far the relative position of the two countries in this industry has been affected by an open competition. Add to this that fashion, always capricious and arbitrary, has exhibited of late more than ordinary fickleness in all matters of design, especially in ribbons and trimming. Making every allowance for the difficulty of the time and the extraordinary circumstances under which the manufacturers of silk have been labouring, this is certainly a fine standpoint for studying the condition

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and prospects of this branch of industry, and the Universal Exhibition affords us abundant materials for such a study.

The cocoon worm and wild silk.

The first object of interest in connection with silk is the cocoon, of which there are many illustrations. Over and above the cocoons of France, Italy, and other European countries, which are, generally, varieties of the Bombyx mori valuable specimens are exhibited of the Bombyx arrindia, Scynthia, Ailante, and the Saturnia Fairdebü, shown by Cochin China, Senegal, and other French colonies. Several species of silkworms have been acclimatised and rendered useful in Europe. Only a few years ago the Abbé Fantoni, a Piedmontese missionary in the province of Hang-Kung, in China sent some living cocoons—the Attacus Cynthia and Ailanthus—to some of his friends in Turin, which yielded moth and multiplied both in Italy and France. And there are numerous silk-producing worms which have not yet attained any commercial importance, not having been employed in manufacture. Some have doubtless been tried and found wanting; but means may still be discovered for obtaining from them a better silk; and it is all important to see whether, by the acclimatisation of new worms, or of other trees than the mulberry, the silk supply may be permanently increased. Of vegetable silk, a specimen is shown by the Cape of Good Hope of a silk-producing bulb, the Amaryllidea. Brunswigia Josephina, which grows wild all over the country, and might be obtained in any quantity. Wild silk is abundant in India and China. Consul Taylor, in his recent report on the trade of Diarbekir and Kurdistan, referred to a specie of wild silk, called guz and jez, which grows extensively in the Bohtan mountains, and about Rawandoz and Zacho, in the Mount Kaimakhih. The insect seems like a caterpillar, and forms the cocoon in a shrub; yet it does not die there, but escapes and becomes a butterfly. Though in many respects totally different from the silkworm, the silk is much prized by Kurdish women, who make it into a variety of dresses, the material being very strong. We have no specimen of this at the Exhibition; but such an instance ought to sharpen the eye of our silk manufacturers, and stimulate them to do what the Cotton Supply Association has done in the way of extending the rearing and cultivation of an article so valuable, and at the same time so attainable, within a zone of many degrees of latitude. On occasions like these how valuable it would be to have a section altogether appropriated to new products, the commercial uses of which have not yet been discovered! The consuls of different countries, scat-

tered as they are in the most distant localities, might furnish valuable contributions, and scientific commissioners might be appointed to examine and report upon them.

Raw silks.

Raw silk, including tram, singles, and organzine, is exhibited by France, Algiers, Italy, Austria, Spain, Portugal, Russia, Turkey, India, Victoria, and other countries, though the exhibition is, as a whole, far from complete. It will be observed that the French and Italian samples are in many cases the produce not of French and Italian cocoons, but of eggs obtained from the East and other places where the disease has not penetrated. And it is gratifying to find that Italian silks made of such seed are yearly acquiring greater perfection. The Japanese seed worked in Italy loses in time its sharpness and want of colour, and accquires the natural softness and elasticity proper to Italian silk. There is something inherent to Italy which renders her, notwithstanding every difficulty, the privileged home of the finest description of raw and organzine silk. The spinning of silk is becoming more and more a manufacturing industry, and everywhere large spinning-mills are being erected, worked by steam-power. Some of the best samples in the French department are from Ardèche; in the Italian, from Milan. Austria, too, has a good exhibition. Russia produces a quantity of silk, principally from Caucase; but the cocoon is sent to Moscow and St. Petersburg, where the manufacture is carried on.

Sewing silks.

Together with raw silk and organzine, the visitor will see a great variety of sewing silk, or soie à coudre, à broder, raw and dyed, écrues et teintes, as well as bourres de soie, spun, raw, and dyed, for sewing. The infinite variety of shades of colour here exhibited is remarkable, and, with the extensive use of chignons for ladies' head-dress, it will be seen how art is made to supply the deficiencies of nature, and how difficult it will become for keen observers to detect the true from the artificial, in this as in other portions of personal ornaments.

Silk manufacture.

It is not, however, the cocoon, the raw, or sewing silk that forms the attraction in this class. The great wonder is the silk manufacture itself, which is more than ever distinguished for lovely hues and beauty of design. If, on the one hand, the new colours obtained from aniline and other chemical products have supplied a greater variety of tints than could be obtained from vegetable sources, it is quite evident that the genius of the artist is more than ever visible and eminently happy. In such an article as silk, and indeed, in most descriptions of textile materials, a good and

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well-executed design is a primary condition to success. The first element to strike the eye, it is certain to enrich every material; and, when texture and design enter into competition, with the great majority the latter is sure to obtain a decisive victory. Art-designing is itself an important industry in Paris; and to her artists the manufacturers resort in order to produce constant novelties in their tissues, shawls, ribbons, brocades, and embroidery.

Superiority of French designers.

But what is it that renders French designers so fertile in imagination and so striking in conception? What is it that enables them to invent designs which either guide public taste or promptly follow that taste and ennoble it with their touch? There is much, doubtless, in a national character full of versatility and quick in perception, in a climate and temperature favourable to the growth of flowers possessing high brilliancy of colour and great perfection of form; but there is more in an artistic education carefully tended and cultivated, not only by the actual teaching of art and design, but by what is still more fitted to awaken the mind to the true and the beautiful, the constant association with the highest models of art in public galleries and churches, in gardens and boulevards. Means of spreading artistic instruction are now provided in the principal States of Europe. In France, schools of design are established in the great centres of manufacture. There science and art are deemed not the luxuries, but the necessities of manufacturing industry. Lyons is rich in her schools, national and martinière (from the name of its founder); and from Paris emanate the highest inspirations of taste, elegance, and invention. The Rhenish Provinces of Prussia abound with art-schools; so do Belgium, Wurtemberg, Switzerland, &c. Every nation is putting forth her maximum energy, with a view to the embellishment and refinement of manufacturing industry and the elevation of public taste. And Britain should not remain behind in a matter so essential.

Illustrations of remarkable specimens in French silk goods.

The most striking specimens of silk manufacture at the Exhibition are certainly to be found in Lyons and St. Etienne. Let the visitor scan carefully the collective exhibition of the Association des Tisseurs de Lyons (251). Let him observe the splendid tapestry or damask silk exhibited by Messrs. Pillet-Meauzé et Fils (102), and that of Messrs. Methevon and Bouvard (148), equally sumptuous. And what shall we say of the taffeta brocaded silk with lace patterns relieved by wreaths of flowers, or of that other taffeta silk with velvet representing birds, flowers, and feathers, which seem as if you could pick them up? The illustrations of

woven silk will perhaps give some idea of the degree of excellence now attained in this manufacture. The first of these, exhibited by Messrs. Poncet, Papillon, and Girodon (164), is

Fig. 1.—PORTION OF A SILK DRESS BY PONCET, PAPILLON, AND GIRODON.

a broché silk robe, the pattern at the bottom representing drooping flowers. The centre large flower forms a new feature in silk weaving. It is raised so as to represent velvet,

by a new process, the "velvet" being raised after the silk is woven. The second, exhibited by Messrs. Schulz and Beraud (207), is a robe of taffeta-coloured silk, the pattern

Fig. 2.—TRIMMING OF OSTRICH FEATHERS, BY SCHULZ AND BERAUD.

woven on black velvet. The engraving represents the front half of the dress, the pattern on a smaller scale running round the bottom of the dress. The third is woven in the

loom to imitate hand embroidery, representing natural flowers on a satin ground, to be used for chair seats, pillows, or screens. In brocade silks with gold and silver the visitor

Fig. 3.—CUSHION AND CHAIR COVER (BY LAMY AND CO., OF LYONS).

will meet with some magnificent descriptions at M. Sagnier-Teulon, of Nismes (81). Beautiful is the satin with feather ornaments exhibited by Messrs. Hielard, and Co.; and so are the gauze tissues with silk and velvet flowers by Messrs. Josseraud, Févrot, and Co. (221). In moire antique there is something beautiful, especially in fancy water patterns. All around the Lyons department the visitor will meet with specimens remarkable for chasteness of design, excellence of material, and elegance of ornamentation. These *tours de force* are doubtless isolated instances of perfection, reached probably at a cost far too high for general application to ordinary articles of trade, yet they serve the important purpose of indicating what may yet be achieved, as well as of facilitating the way to general improvement. And they do find a market especially in France, England, and the United States. Many, in fact, of the most expensive and superb robes made at Lyons, and those, the engravings of which we have given, are exclusively manufactured for an English house, Messrs. Grant and Gask. At the St. Etienne

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department, the brocade ribbons of M. Larcher-Faure (129), the velvet ribbons of Messrs. Barallon and Brossard (106), and the ribbons made for fans of Messrs. Dessales and Co. (117), well merit a visit. In silk velvet, both Lyons and St. Etienne have fair samples. The more, indeed, we examine and study the French exhibition of the silk manufacturers, the more we are convinced that, however unfavourable the circumstances may have been as regards the raw material, the French manufacturers have not abated one iota in their efforts for improvement.

French ribbons and velvet.

Swiss ribbons and plain silks.

Switzerland has a good exhibition of exceedingly light and low-class silks. They are plain in taste, but very useful, and sure to find an extensive market. Zurich, the great centre of the tissues, and Bâle, the chief seat of the ribbons, have both acquired much reputation in foreign markets, and at this Exhibition they fully maintain their position of pre-eminence. The most remarkable feature in Swiss silks is the extreme beauty of colour, the lightest and most delicate tints altogether unaffected by the touch of the hand or by atmospheric impurities. Italy, too, exhibits a good deal. She has her old Genoa velvets, of world-wide renown, and she has silk brocade and tapestry of much merit. But the Italian manufacturers, not courageous enough to meet boldly the competition with France, lose golden opportunities for reacquiring the position which they once held. Surely, of all lands Italy should be second to none in purity of design and liveliness of colour. Austria produces tapestry silks of great beauty. Spain has some fine specimens from Valencia and Barcelona. Tunis exhibits good tissues of silk and silver. India has some rich samples of silk tissues, and silk with gold and silver. Russia shows some excellent silks from Moscow; and a good deal is exhibited by Prussia and the Zollverein, especially in silk velvets and ribbons.

Italy.

Austria.

Spain.

Russia.

Meagre exhibition British silk manufacture.

As for Britain, her exhibition is very meagre; she evidently excels in her moire antiques, Irish poplins, and black crape, and she has excellent plain and glacé silks; but she exhibits no specimens where beauty of design is observable, though there are some honourable exceptions. What, for instance, could be more elegant than the *Tissue de Verre* for silk curtains, couches, and chair coverings exhibited by Messrs. Grant and Gask, of Oxford Street? Of all the uses hitherto made of glass, this seems certainly the most wonderful. Who would conceive that that brittle material could become sufficiently flexible as to be woven like a textile fabric? There is something very beautiful in

Tissue de Vere.

the amalgamation of this lustrous material with the finest silk; and I do not wonder that it has been largely used for the ornamentation of palaces and public buildings. As a whole the British silk manufacture is certainly not so conspicuous at this as at the former Exhibitions, and it is a singular fact that, whilst in 1862 Britain, almost alone, showed great improvement in design, colour, and texture, in 1867 she exhibits no mark of progress. The result of the competition was seen at the distribution of prizes. Five French silk manufacturers were honoured with the Legion of Honour. The town of Lyons carried off the grand prize; and of 12 gold medals four were gained by France, awarded to the Chambers of Commerce of Lyons, St. Etienne, Paris, and Ardèche. Switzerland got two for Zurich and Bâle; Italy one, Great Britain one, the Chamber of Commerce of Vienna one, and Turkey, Prussia, and Russia one each. Of 144 silver medals, 105 were given to France, 13 to Britain, and 10 to Italy. Of 135 bronze medals, 17 went to France, 17 to Italy, 14 to Austria, and 10 to Britain; and of 156 honourable mentions, 57 were awarded to France, 50 to Italy, 9 to Austria, 8 to Britain; and the remainder to other countries. The number of honours granted to any country must, of course, be calculated in proportion to the number of exhibitors; still, it is evident that the position of the United Kingdon is not what we could wish, especially in relation to France, which has taken the lion's share of all medals and honours. How shall we, then, account for this when we look back to the high position Britain had acquired at the Exhibition of 1862? Whence this sudden stoppage? Is it the effect of the high price of the raw material? If so, why has it not operated in like manner in France? Is it the consequence of unequal competition? But why should Britain be behind her competitors? Let us, first of all, clear up the real facts of the case.

Prizes and medals.

Causes of British inferiority.

Within the last 25 years there has been a great oscillation in the imports of raw silks. In 1840 the imports amounted to 3,759,000 lbs.; from that time they increased enormously, till, in 1860, they reached 9,200,000 lbs. But afterwards there was a considerable decrease, and in 1867 they were not more than 5,800,000 lbs. The greatest fluctuation has taken place in the imports from China, the quantity having first risen from 5,000 bales to 67,000 bales, and afterwards fallen to 26,000 bales. From India the importation has been stationary; and so from Persia. Of Brutian silks the imports have dwindled to nothing, and from Italy they have been reduced to very little.

Fluctuation in the imports of the raw material.

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Nor is this all. In consequence of the disease in the silkworm, France, Italy, and Germany have become great competitors in the British markets for China and India silks; and now, when we deduct the exports, the quantity remaining for home consumption is actually less than it was 25 years ago. In 1840, of 3,800,000 lbs. of silk imported, 3,600,000 lbs., or 94 per cent. of the whole, were left for home consumption. In 1860, of 9,200,000 lbs. imported, upwards of 6,000,000 lbs., or 65 per cent. of the whole, were left for home consumption; and in 1867, out of 5,800,000 lbs. imported, 3,900,000 lbs., or 67 per cent. of the whole, were used at home. Under such circumstances the prices of raw silk have risen considerably. According to Messrs. Durant's circular China silk, which on January 1, 1855, was worth 17*s.* and 18*s.* 6*d.*, rose in 1867 to 32*s.* 6*d.* and 34*s.*; Bengal common rose from 7*s.* 6*d.* and 12*s.* to 15*s.* and 18*s.* 6*d.*; Persia, from 9*s.* 6*d.* and 11*s.* 6*d.* to 15*s.* and 22*s.* 6*d.*; Italian raw, from 19*s.* and 21*s.* to 38*s.* and 40*s.*; and thrown, from 23*s.* and 26*s.* to 42*s.* and 45*s.* per lb. And in an industry where the raw material enters so largely in the total value, a rise of 80 or 100 per cent. upon such material left but little surplus either for labour or capital. This is an element which renders the silk manufacture always less profitable than the cotton or woollen, where the raw material is of little value or is indigenous to this country; and we need not wonder if, under such circumstances, these obtain decided preference for the investment of capital.

Increased exports of raw silk from Britain.

Following the unsatisfactory condition of the raw material, the exports of British silk have suffered greatly. In 1846, when Sir Robert Peel reduced the duty on silk manufactures from 30 per cent., as it was left by Mr. Huskisson, to 15 per cent., the value of exports amounted to no more than 608,000*l.* From that time it increased regularly, till in 1856, the value amounted to 1,758,000*l.* Soon after, the disease in the silkworm appeared, prices rose, and the cheaper descriptions of silk became dearer in proportion than similar articles in wool or other materials. Then, too, in 1860 America, our chief market, became the prey of a fearful civil war, and the exports fell in 1861 to 1,395,000*l.*, and from that time they further fell to 1,028,000*l.* in 1867. Even the six months ending July 1867 showed a considerable diminution as compared with the similar period in 1866. To a certain extent the check to the prosperity of the manufacture has been as much felt in Lyons as in Spitalfields and Manchester; but whilst England did not get the better of it, France did. Of ribbons, for instance, in 1851 the export from

Effect of free trade on the silk manufacture.

Arrest of progress effected by disease in the silk worm.

France amounted to 1,200,000*l.*; in 1855 they rose to 4,700,000*l.*; and in 1861 fell to 1,800,000*l.*, but they have since recovered to 3,500,000*l.* in 1866.

The silk trade in France and England.

The silk trade in France, as a whole, exhibits a very different progress from that of England as regards the exports of silk manufacture. When the two are placed side by side the comparison is very striking:

| — | Exports from England. | Increase per cent. | Exports from France. | Increase per cent. |
|---|---|---|---|---|
| 1851 | £1,130,000 | — | £7,350,000 | — |
| 1855 | 1,082,000 | 4 | 9,650,000 | 31 |
| 1861 | 1,395,000 | 28 | 11,560,000 | 20 |
| | | Decreased | | |
| 1866 | 1,318,000 | 5 | 1,850,000 | 63 |

The difference between France and England from 1851 to 1855, and from 1861 to 1866 is very notable.

What, however, alarms the British manufacturer is the fact that, whilst the exports of British manufacture decreased, the imports of French and other foreign manufactures have greatly increased. In 1855 the real value of foreign silk manufacture imported was only 1,800,000*l.* In 1860 it was 2,800,000*l.*; and in 1867, 8,000,000*l.* There is nothing surprising in the fact of such increase, the diminution or abolition of import duty being always followed by a larger trade, by which the community at large is benefited. Only in this case the natural result was still more sudden, from the fact that just when we opened our ports, the American markets being closed, a large portion of French and German silk, which would otherwise have been sent thither, found its way to this country. From these accumulated evils, the manufacturer in this country has been placed under no ordinary straits and difficulty; and there is no doubt that thereby the ability of England to compete with France in certain descriptions of silk manufacture has been greatly put to the test.

Advantages of France, particularized in climate.

The French, Swiss, and Germans have the advantage of a brighter atmosphere, and France, especially, besides producing her own material to a large extent, stands out pre-eminently as the leader of fashion; still, in the processes of manufacture, and in the cost of the raw material, the different countries are pretty much on a par. The wages of labour in this manufacture are very low, both in this and in other countries; and, if they are a little higher in England than elsewhere, that is probably more than made up by her superior power of productiveness. It is not, indeed, by starving the labourer, or by employing cheap and inferior

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labour, that the British manufacturer will ever be able to meet the competition. On the contrary, the most prominent want in an industry so light and delicate is a higher class of labourers, more educated, more refined in taste, and even more expert in material and texture. As to protective duties of any kind, the idea is quite exploded that any fictitious protection against the competition of foreign manufacture can do much towards propping up native industry. The prosperous maintenance of a manufacture in any country mainly depends on the natural facilities and advantages which the nation may possess for it, and on the energy, aptitude, and skill displayed by the manufacturers themselves. Sound principles of commercial policy dictate that if the foreign manufacturer can produce for us any article better and cheaper than we can produce ourselves, we should let them do it, it being vain and preposterous to think that we should shut the foreigners out to foster artificially any branch of British manufacture. The British silk manufacturer must, like the cotton and woollen manufacturer, learn to be independent of legislative support. He must endeavour to improve his own production by attending better than he has hitherto done to the conditioning of the silk, to the perfect adaptation of the silk he uses to the material he wants to produce, to the proper manipulation of colours, to the novelty of design, and, above all, to the finish of the article. Let it be remembered that the inferiority of British silks is not confined to those tissues where design is the primary element, but that even in the black corded silk, the French are superior. It is very true that the French have to a large extent succeeded, by imparting to their plain silk an artificial weight, which gives to it an appearance and a value beyond its real worth; but that is not all. In truth a higher standard has been attained by France in every description of silks, and the British manufacturer must strain every nerve to place himself in a better position than he seems to be at present, if he will not be ousted altogether in the keen but wholesome competition which has now been irrevocably established.

Great use of shawls.

The shawl seems to be the most useful and most universal of all articles of dress. On the head as a turban, and over the head as a hood, twisted round the neck, folded round the shoulder, or wrapped round the waist as a girdle, at times forming the entire dress, and at other times being but an adjunct of luxury, falling in graceful folds on the person: in every way it is suitable and becoming. In size, too, how different. The shawl used for the turban is of extreme length, often as much as sixty yards. The scarf is of endless

variety of length and breadth; the ordinary plaid from the size of a long shawl to that of a common handkerchief. And in material we have it in wool of every degree of fineness, in cotton and silk, in mixed materials with gold and silver, and in lace of the finest texture.

The Cashmere shawl.

First in quality and design is certainly the Cashmere shawl, for which the visitor will visit the Indian department. Let him observe the fineness of the material used for the purpose. It is the soft downy substance found next the skin and below the thick hair of the Thibet goat. Then the design, which is ordinarily the pine, with ornaments of great variety; then the beautiful combination of colours; and, finally, the finish of the article so perfect as a whole. There are shawls exhibited by India of great value, such as the square Cashmere shawl with violet centre, exhibited by Dewansing, and the Dopatta shawl, from Delhi. These far surpass any other for rarity and absolute worth. So jealous is the Maharajah of Cashmere to maintain the reputation of such shawls, that he has recently taken steps against any deterioration in the quality of those manufactured in his dominions.

French shawls.

After India, the visitor had better go at once to examine the shawls exhibited in the French department, just opposite the silk, where, with much that is inferior, he will find many shawls of unsurpassing beauty. France is doing her utmost to imitate the Indian shawl in material, colour, and ornamentation. The specimen given in the Illustration of a shawl manufactured by Lecoq Gruyer, of Paris, is, indeed, a wonderful copy of an Indian shawl, not easily distinguished from the best cashmere. The richest descriptions are made in Paris, the middling in Lyons, and the inferior at Nismes. The shawls exhibited by Messrs. Lacassagne, Deschamps, and Salaville, and especially the one in the centre of the group, are exceedingly fine. A rich velvet shawl, embroidered by hand, with chenille fringe, well merits a visit, and so do the shawls embroidered by machinery. France has a large trade in shawls. The value of exports of shawls from France which, in 1851, was 640,000*l.*, has since increased to about 1,000,000*l.* Austria, too, has some splendid shawls, exhibited by Messrs. Halawatsch and Isbary, of Vienna (14). The Austrian manufacturer gives a precision to his design worthy of imitation. Prussia exhibits great variety of tartan and plaid shawls, but of inferior descriptions.

Paisley and Norwich shawls.

As for England, the Paisley shawl of superior wool and excellent design, and the silk shawls now produced in Norwich by Messrs. Clabburn and Sons, figure most favour-

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ably; whilst the plaid and tartan shawls exhibited by Messrs. Kerr, Scott, and Co., Messrs. Hitchcock and Williams (2), and Messrs. Romanes and Patterson, are unrivalled for brilliancy of colour and variety of clans. In the cases of

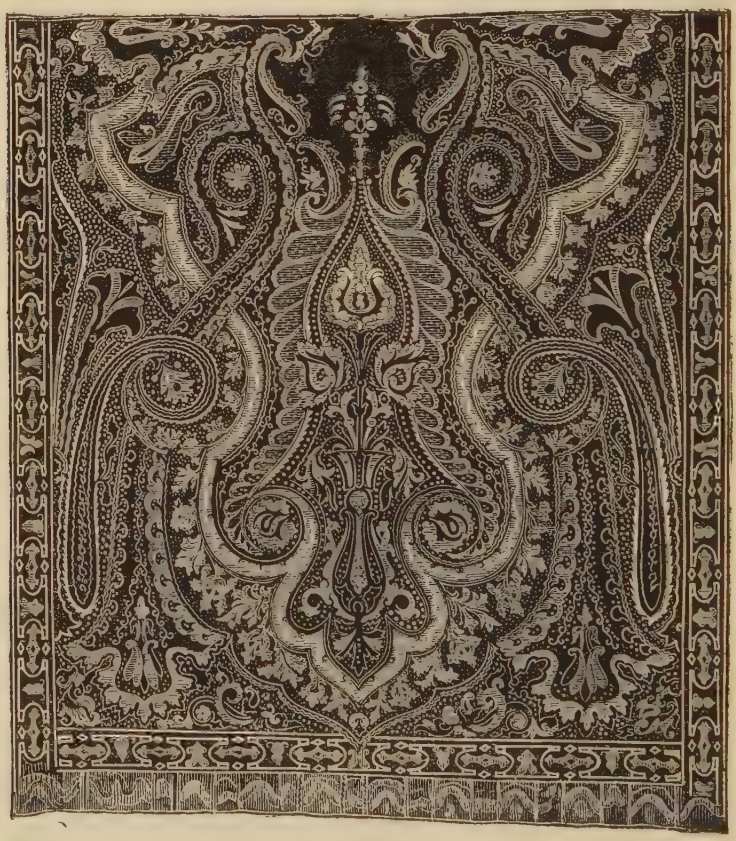

Fig. 4.—FRENCH CASHMERE, A PERFECT IMITATION OF INDIAN CASHMERE.

Messrs. Hitchcock and Williams 70 or 80 different patterns are shown, representing the plaids worn by the ancient Scottish clans, together with some fancy plaids, such as the Victoria, Eugénie, and Napoléon. Two gold medals only were awarded for shawls: one of these was given to Dewansing and one to the Chamber of Commerce of Paris. Of 15 silver medals, 11 went to France, three to Britain (of which two to India and one to England), and one to Austria; of 25 bronze medals, 12 to France, five to Prussia, and three to Britain; and of 26 honourable mentions, six were given to France and five to Britain.

Prizes and medals.

Upon the lace shawl, and on lace and net generally, I shall not enter, a lighter and more accomplished hand having undertaken the difficult and delicate task of appreciating their worth and beauty. This much I will say, that the hand-lace exhibited in the French and Belgian departments is really something very superb. A piece of lace is, perhaps, the most ingenious result of artistic skill that can well be conceived. The more we examine the extreme nicety of the operation, the fineness of the thread so well knit together, the fairy-like web woven for it, and the beautiful figures of the pattern, the greater seems the marvel of the achievement; and well may we be grateful to Nottingham for the prodigious feat of performing so nice a work by mechanical agency.

Lace.

Of embroidery the Exhibition is full, whether by hand or by machinery, so largely does it enter in articles of dress and household furniture. Apart from white embroidery, which will be dealt with in connection with lace, the most prominent description is the gold and silver embroidery used in ecclesiastical vestments and furniture, in the shape of albs, copes, chasubles, cassocks, surplices, and altar-pieces. In these articles France, Italy, Austria, Spain, Russia, and other countries seem to vie with each other in beauty of design and magnificence of material. But let the visitor not miss the Italian specimens. The raised work there is something very fine, and there is no difficulty in finding them, so prominent are they and so beautiful. The art of embroidery in gold and silver is of old date, but seldom has it been carried to such an extent as at this moment. Britain does not exhibit much in this class of articles; and what she has falls far short of the excellence and vividness which distinguish the foreign manufacture. The visitor should note the gold and silver thread used in Indian manufacture, which is not in the shape of a wire, but simply a narrow band beaten on the common thread. In the Lyons department Messrs. Uze, Fils, and Co. exhibit a sample of gold and silver thread of extraordinary fineness. In this class, too, are included small wares, passementerie, or trimming, which fashion has once more revived to an enormous extent. They comprise fringes, girdles, laces, cords, buttons, loops, braids, &c., used in ladies' dresses, carriage furniture, and ornaments. Look at those cases in the French department, with gold laces and other braids and trimmings, for court or livery costumes! See those beautiful buttons of every variety of material in metal, glass, ivory, silk, wool, and cotton, and in the most fantastic shapes! See those coach laces, so chaste and beautiful! What can be conceived more perfect than those

Embroidery.

Gold and silver embroidery.

Passementeries, or trimming.

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epaulettes and other military costumes? In curtain hangings, too, there is great variety. Paris is the great centre for passementerie; by the use of always the best material and the exercise of a boundless imagination in design, the French have secured for themselves a decided supremacy. Since the Exhibition of 1851 the exports of passementerie from France has increased from 267,000*l.* in 1851 to 1,400,000*l.* in 1866. Many other countries have excellent specimens in trimming, more especially Prussia, Russia, Austria, Italy, Greece, Nuremberg, and Wurtemberg; whilst Switzerland has beautiful straw trimming, and France has imitation straw of great beauty. Of Berlin woolwork Prussia has an excellent exhibition; so have France and Austria. But how is it that England exhibits almost nothing in this important branch, when the exports of small wares, trimming, and fringes are considerable? The reason probably is that our manufacturers content themselves in producing cheap goods, and, in most cases, without much originality of design. As might well be imagined, the awards in this class are principally favourable to France and Belgium. Of seventeen gold medals, ten went to France, four to Belgium, and one to Britain (to the town of Nottingham); of seventy-seven silver medals, forty-eight went to France, eight to Belgium, and four to Britain; of one hundred bronze medals, fifty-one to France, eleven to Belgium, and nine to Britain; and of ninety-two honourable mentions, thirty-two to France, fourteen to Italy, seven to Belgium, and three to Britain; the remainder to other countries.

Great trade of France in trimming.

Fig. 5. — HAND EMBROIDERED TRIMMING, BY EMERY, OF LYONS.

Prizes and medals.

Hosiery and other articles of underclothing.

Hosiery is largely represented in the French, German, and British departments. France is rich in fancy articles, such as ladies' silk stockings with open lacework and embroidery,

mittens, scarfs, and veils. Britain excels in articles really sound and of the finest make; whilst, for bleach and finish, the Nottingham cotton hosiery is unequalled. But some of the largest manufacturers are not represented, and we do not see to the full extent the power of the British hosier to adapt his goods to all the markets of the world. For marvels of cheapness we must visit Saxony; and certainly I was not prepared to find another country producing machine-made articles at lower prices, though inferior in quality, than Britain. Other articles of underclothing—such as shirts and fronts in great variety and beauty, with and without embroidery; stays of the most elegant form; crinolines and jupons—are shown by France in great abundance. Here, too, are fans, some in the finest lace and with exquisite mountings; others adorned with pictorial representations; others of feathers, and others remarkable for cheapness and taste. Umbrellas and parasols are largely exhibited, as well as sticks, whips, and an endless variety of objects adapted for ornaments and for ordinary use. But I cannot attempt to particularise any one of the numerous articles, and the visitor will have no difficulty in selecting the choicest patterns. The prize list gives us some idea of the character of these varied exhibitions. There were six gold medals in this class, of which France took five (two for hosiery, two for buttons, and one for fans); of 82 silver medals, 62 went to France (for her gloves, corsets, buttons, &c.), and only two to Britain; of 129 bronze medals, 78 to France and five to Britain; and of 137 honourable mentions, 48 to France and 28 to Britain, of which, however, the greater part went to India for fans.

Ladies' dresses.

As we enter the grand vestibule from the principal entrance the most striking sight on the French side is the exhibition of ladies' dresses by Messrs. Enout and Co. The beauty and excellence of such dresses do not consist so much in the material, though it is always of the finest, as in the make and trimming. The illustration here given is a pattern of embroidered trimming and pansies introduced this season, and made first by command of the Empress Eugenie. It is very splendid, and when applied on taffeta silk in colour, either corresponding to the principal flower, or forming a strong contrast to the trimming, the effect is beautiful. How bizarre, too, are the fancy dresses for balls, close at hand, and how charming are those children's dresses! It is of no use to deny it, the French have a peculiar ability for such things. We may wonder how is it that every nation receives the fashion from France, and why should a dressed doll from the Rue St. Honoré give at once the tone

Universality of French fashion.

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to Europe and America? All we can say is that every nation has its own spécialité. England is famous for her minerals and machinery; Spain and Portugal for their wines; Italy for her objects of art; and France for her fashion. Dressmaking in France forms two separate industries. First, are the couturiéres or dressmakers, who work only by measure for private customers, but whose taste and skill are extensively known abroad; second, are the "Maisons de Nouveautés," specially for the sale of ladies' dresses, all prepared, which give forth things very superb and generally cheaper than they can be produced by dressmakers. It is to this class that Messrs. Enout and others in the vestibule belong. The modiste has a distinct profession, and she confines her attention to head-dress in the shape of bonnets and coiffure for balls and soirées. The manner in which the flower, blonde, or lace is to be adjusted is entirely a matter of taste, and the triumph of art consists in the constant renewal of form, constituting in each case a novel and original fashion.

Exports of vêtements from France.

The export of vêtements from France have immensely increased of late. In 1851 their value was about 1,000,000*l.* in 1861 they amounted to 3,400,000*l.* and in 1865 to 5,000,000*l.* But from the United Kingdom also the exports of apparel and slops increased from 1,000,000*l.* in 1851 to 2,000,000*l.* in 1861, and 2,200,000*l.* in 1867. In ready-made clothing the only countries which have some remarkable specimens are France, Belgium, and Austria. Separate articles composing the dress of ladies and gentlemen, a rich collection, is found at the Universal Exhibition.

Hats.

Hats are largely exhibited, with the great desiderata of form and lightness. The specimens at the Exhibition indicate fully the progress which has been made in this manufacture. To say nothing of the common hats covered with silk plush, with the foundation of cork, felt, or cotton, or of hats made of felted wool, I may notice the various descriptions of straw hats shown by the South American States. Malta shows the very cheap straw hat worn by seamen. The Cape of Good Hope has a fibre, the Juncus Serratus, which makes excellent hats, very strong, and impervious to rain, wind, and sun.

Straw hats.

Caps.

Bonnets.

Italy has her straw hats and bonnets of exquisite fineness. England too, has an excellent exhibition of chips. Of caps there is great variety. Austria excels in the red cloth cap, with a long tassel. Eastern countries have caps highly ornamented and embroidered with gold and silver; and Britain has the common and extensively-used glengarry. Ladies' bonnets are exhibited in abundance, especially by France, if we can call bonnets the strips of silk ribbon or straw intended to set

off a monstrous chignon. There are at the Exhibition bonnets with ivory and pearls, bonnets composed entirely of feathers, others of glass, others of reeds, bonnets of straw, and bonnets of fancy materials of every description.

Boots and shoes.

Of boots and shoes there is much exhibited; boots made by machinery occupying everywhere a prominent place. Also impermeable boots of indiarubber and other materials. Great novelties are shown in ladies' boots and slippers, both in shape, material, and ornamentation, especially in the French and Belgian departments.

Artificial flowers.

Artificial flowers abound in the Exhibition, and there is something very beautiful among them. The French cases are exquisite. The gold and silver filigree flowers for coiffure, exhibited by Prevost Bernard, of Paris (43); the head-dresses of ostrich feather and birds of paradise; the wild flowers in feathers, by Carchon (65); all are very fine. Austria has a beautiful group of flowers; and so has Turkey and other countries.

Feathers.

In other articles for and of dress there is great abundance. Ostrich feathers of great beauty in length and breadth are exhibited by our colonies, especially the Cape of Good Hope. As for muffs, capes, and furs, it seems that use is now made of the feathers, furs, and downs of beasts and birds of every latitude.

Prizes and medals.

In this important class five gold medals were awarded, four of them went to France for her artificial flowers, preparation of dresses, boots and hats; and one to Austria for her dresses. Of 76 silver medals, 45 went to France, six to Austria, four to Britain; of 183 bronze medals, 92 to France, 14 to Austria, and 13 to Britain; and of 190 honourable mentions, 52 to France, 19 to Belgium, 19 to Italy, and nine to Britain.

Costume of different nations.

But it is time to pass to class 92, comprising specimens of clothing worn by the people of different countries. It is certainly a novel and interesting feature in this exhibition to have all around lifesize figures dressed in the native costumes of almost every country on the face of the earth. I cannot say how far the figures may be taken to represent the ordinary dress of the people; to what class, high or low, each or any of them may belong; whether the dress is that of a gala day or of a wedding costume; but, assuming that, generally, we have before us the customary and popular dress now worn, what a study does such a collection afford! Setting aside altogether any artistic or ethnologic consideration, the merchant and manufacturer will see in them the most valuable guide for the production of articles of export. It is quite evident that since every country has its own recognisable costume or general style of male and

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female attire, over and above those niceties of colour and texture of dress, which fluctuate according to taste or the whim of fashion, without due attention to these facts we cannot hope for an extensive outlet for our manufactures. It is vain to imagine that old and stationary nations, like India and China, will change their habits and dress to suit the European trader. It is comparatively easy for the French to spread their fashion among European nations in articles of finery; but when England sends articles of ordinary use to nations traditionally opposed to all change, unless she can send them things which they are accustomed to wear, which suit their manner and clime, wear as long and well, and are cheaper than they can manufacture them themselves, they will not buy them of her. Bearing in mind, then, the real mercantile value of such an exhibition, let the visitor see, principally, the materials composing the dresses in such costumes. Where they consist of native cloth, let him carefully examine the texture. Let him distinguish the articles made as piece goods generally from those woven in pieces fitted for use; let him notice the style and make of the dresses, what ornaments are used, how they are worn, and generally the character and type of the design seemingly popular in the different countries.

Morocco.

Suppose we enter from the central garden, by the Rue d'Afrique, into the eastern group of countries, we first alight on Morocco, and there we find a lady with two jackets of orange merino, embroidered with gold and silver, a large broad scarf of silk and cotton of bright colours, a net robe, a coloured silk handkerchief on the head, and velvet shoes richly embroidered with gold. A little further, after passing Tunis, to which I shall refer presently, there is a group, among whom are two Jewesses and a Moresque, the former with robes of beautiful silk velvet, richly trimmed with gold lace, under-vests equally rich in gold embroidery, loose sleeves of silk and gold gauze, silk scarfs on their heads, and a gold and silk scarf wrapped round their waists. The Moresque, with a purple vest and scarlet robe, both richly embroidered with gold, a silk and gold waistband, a scarlet shawl on the head, with a long white-striped scarfs over all.

Tunis.

In Tunis there is a Bedouin Arab, with a brown cloth coat and trousers embroidered with gold, a white bernouse fastened on the head, and a silk shawl as a girdle.

Egypt.

In Egypt we see a Cophte woman, with a mauve silk dress, a black silk mantle, waistband embroidered with gold, a muslin chemise, and head-dress with long veil covering the face, except the eyes. A rich fellah, with a robe of red and yellow silk and cotton lined with calico, a silk shawl round the waist, a fine crimson coat, a white muslin turban, and

red shoes. A negress servant, with gold and silk cerise dress trimmed with gold lace, a coarse muslin chemise, and a tulle veil with flower borders for head-dress. And a Barbary Süis, with a white calico dress, a large silk and wool shawl twisted round the waist, a black cloth vest embroidered with gold, and a red cap.

Turkey. Turkey exhibits a great variety of rich costumes. There is the Albanian, with trowsers of scarlet silk, a full tunic of white cotton, a double jacket of scarlet cloth with hanging sleeves of striped gauze, and a magnificent girdle richly embroidered with gold. There, too, is the Circassian, with a black cloth coat, with gold and silver lace, and a fur cap on the head; his lady having a purple satin robe with gold and silver lace in front, a crimson velvet jacket with gold, a deep cloth cap, and very singular cuffs in the horseshoe shape.

China. The costume of China may best be seen from the colony of native Chinese in the park, and it evidently consists, either of a long cloth robe, a black silk jacket, and a small blue cap, or of a dark silk dress and brass buttons, straw-coloured silk trousers lined with blue.

Siam. Of Siam there are two illustrations, showing the ordinary dress to be robes of red China crape, calico shirts, and calico scarves round the waist, and huge straw hats in the umbrella shape.

India. India does not exhibit any complete costumes, though she has many illustrations of the different articles which ordinarily enter into the Indian dress. Dr. Forbes Watson, in his able and important work on the textile manufactures and costumes of the people of India, shows, first of all, how general is the use of the turban. Its material is either fine muslin texture, or cotton for the lower classes or silk for the higher. In colour it is red and yellow, green and purple, and occasionally even black; and is made all of one piece or strip, nine to 12 inches wide and 15 to 25 yards long, with an ornamental border, often with gold thread at the end. The usual male dress a dhotee, is a piece of cloth wrapped round the loins, the end of which, after a couple of turns round the waist, is passed by the Hindoo between the legs and thrust under the folds which cross behind. A longee is also used as a scarf for wearing over the body and shoulders in a variety of ways. It is generally made of plain cotton, with or without coloured borders and ends, or with silk borders ornamented with gold. For female attire, the chief article is the saree, a long scarf which both envelops the body and acts as a covering to the head. As usually worn, one end is passed twice round the waist, the upper border being tied in a strong knot and allowed to fall in graceful folds to the ankle, thus forming a sort of petticoat or skirt;

the other end is passed in front across the left arm and shoulder, one edge being brought over the top of the head. It is then allowed to fall behind and over the shoulder and arm. The Indian costume is very simple ; in most cases it

Fig. 5.—MODES OF FOLDING OR MAKING UP TURBANS.

consists of only one article of dress, yet there is great variety in the cloth, and more particularly in the embroidery, which is not easily followed. Illustrations of the turban in different shapes as well as of a longee and a saree, are here appended form Dr. Forbes Watson's work. As an example of imita-

tion of Indian manufacture, the visitor will see in the Dutch East India a cloth called baticks ; a little further he will see in Holland, imitations of such baticks exhibited by M. Tho. Wilson, of Harlem. There is no great difference between

Fig. 6.—INDIAN COSTUMES.

"The male figure illustrates the turban-piece and the longee. The female dress shows the long ornamental end of the saree."

them, though the materials used are not quite alike. In the same way M. Sagnier-Teulon, of Nismes in the French department, exhibits a silk tissue with gold, in imitation of Algiers manufacture, the original of which may be seen in the Algiers department. The mode of weaving silk and gold in India and Europe also differs, one using the gold

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thread by itself, the other using a beaten gold band; but there are many things which the manufacturer must carefully study ere he can successfully imitate such native productions. The Eastern costume abounds in gold and silver. Gold texture and gold lace from the commonest tinsel to the finest metal, enter very largely into most articles of dress.

Danubian principalities.

Bordering between the East and the West are the Danubian Principalities. There we see the Roumanian mountaineer clothed with leather dress, embroidered with coloured wool; and the peasant woman with a black woollen skirt, worked with silver, and a jacket of a cotton material called buranqui, sometimes worked with beads.

Greece.

Greece appears to be in a state of transition from the old national Eastern costume to the ordinary European; but we still see the full plaited calico tunic, the richly-embroidered vest, and the red cap with gold tassel.

Switzerland.

In Switzerland cotton, silk, and lace enter most largely into the usual dress of all the cantons.

France.

A singular collection of costumes of the different departments of France gives an idea that the railway has not yet sufficiently penetrated into the interior of that country, or that the masses of people are proof against the inroad of fashion.

Sweden and Norway.

Sweden and Norway exhibit a most picturesque collection of costumes, which a national photographer has beautifully copied. There we see how the coarsest material is rendered useful and becoming by tasteful arrangement and elegant embroidery. To give an instance, there we see a man and woman belonging to the valley of Zatersdalen, in Norway. The man has trousers of fine black cloth, with green stripes, a grey tweed jacket very short in front, with black cloth cuffs and collar. The woman has a dress of cloth, with red and green border and embroidered bodice; a white cotton jacket, with a broad square collar; another jacket of thick cloth, with green cuffs, embroidery, and silver lace; a red cloth waistband, with metal ornaments; a long scarf of woollen stuff, scarlet and white, and a coloured silk headdress.

Denmark.

Denmark, too, shows some interesting costumes, the clothing being composed of black cloth velveteen or chamois, woollen handkerchiefs, and red damask caps.

Russia.

Russia, so vast in territory, with so many races and under so many climes, offers illustrations of costumes of a most interesting character. A Tartar of Crimea has black cloth trousers, with surtout fastened tight round the throat, a stuff scarf round the waist, and an upper robe of green velvet

with broad gold lace. A lady, his companion, has a robe and jacket of crimson silk with gold lace, a gold girdle with large metal clasps, and an upper robe of green velvet with broad gold lace. The Kalmukian has a finely embroidered woollen cloak, an embroidered skirt and silk gown, a bead collar, and a fur cap. The Cossack has a long coat of red cloth with silver lace, dark cloth trousers, a printed-cotton sash, high fur cap, and a leather girdle. A fisherman of Siberia is dressed from head to foot with clothing made of fish-bladder trimmed with fur; and other Siberians from the mountains have skin dresses with bead trimming, cap and cape composed of beads and underdress of leather, and coarse linen drawers and shirts. Some of the Russian costumes are shown in the palace; many more in the park.

Argentine Confederation.

Of the American continent, the only illustrations of costumes appear in the South American department belonging to Chili and the Argentine Confederation.

Competition between foreign machine-made and native-made cloth.

These brief sketches will, perhaps, give a sufficient idea of the great variety of clothing still used by the people of different countries; and it will be seen that, in the majority of cases, the dresses are not made of superfine British or French cloth, but of native woven goods, often of the coarsest quality, yet strong and durable. In fact, foreign cloth, except calico, is seldom seen among them. How shall we sufficiently account for all this? Has machinery failed to cheapen the material of dress for the millions of all countries? Has the ability of England and France, and other great manufacturing countries to make such articles better and cheaper than could be made at home never yet come to the knowledge of the masses of the people? or have the manufacturers never yet understood properly their proper mission, and consequently failed to adapt their merchandise to the real wants of nations? Probably all these causes have concurrently operated to hinder the extensive use of machine-made manufactures. As to cheapness, we must remember that the agricultural population has, in every country, always abundance of time and sufficient ability to make their own cloth for ordinary use; and that, consequently, foreign goods, however cheap they may appear to us, are always dear to those who, having the material on hand, can work it without calculating the value of labour. Then, foreign goods are not, in fact, nearly so cheap as we imagine to the consumer abroad, when the expenses of transport, profits, and charges are added to the original cost, and when heavy import duties are paid upon them. Moreover, as durability is an important element of cheapness, it is quite clear that in this respect machine-made cannot so

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well compete with home-made goods. In countries where fashion effectively controls the manner of dress, durability is not so material an element; the great majority caring less for an article which will last long than for one which has a fine appearance. But it is far otherwise where the masses are beyond the influence of, or not disposed to bow to, Fashion's behests of change and nothing but change. Much may be said, too, as to the fact that the millions in the interior of these countries have never yet become acquainted with the marvels of mechanical production. Distance, want of communication, and difference of language, have kept them isolated; and few are the facilities and means afforded to them to acquire what, in many cases, they might consider a real boon. To the necessity on the part of the manufacturer more carefully to attend to the habits of the nations whose wants he means to supply I have already adverted. It is quite clear that if he intends to replace the home-spun goods among the millions in foreign lands he must make his merchandise cheaper than it can be produced where labour is most abundant—better than it can be made with the greatest waste of material—and in colour and pattern every way adapted to the taste and habits of the people, whatever be its state of civilization and comfort.

Demands for costly articles of manufacture.

Such considerations are, of course, quite apart from what is required to meet the demand for the higher classes, the *bon ton* of society. To know what is wanted for such, let our manufacturers obtain an insight into what is paraded in the saloons of the Tuileries, Ministers of State, and Ambassadors. There they will see exhibited, in profuse and surprising variety, the most extraordinary and luxurious dresses, in the most splendid materials and most elegant style, and charmingly ornamented with lace and flowers. And what is the grand lesson deducible from such a display, but that in articles intended for the wealthy and for special occasions, price is not a material consideration, and that the labour and expense necessary in their production should form no obstacle to their attainment. Let it be the aim of the manufacturer in such cases to arrive at true excellence; and let him not rest satisfied till he produces an article which, like a picture of Raphael or a statue of Michael Angelo, is unique in itself, both in material and design. It is, indeed, by this constant aspiration towards the highest work of art that we can hope to keep pace with the general progress of manufacturing industry in all countries; whilst it should be the ambition of our manufacturers in all their productions, be it in the richest or lowest material, in the simplest or most luxurious design, to have a scrupulous

regard to the requirement of art, and the advance of civilisation, and to keep in mind the need of spreading everywhere what is gentle, tasteful, and ornamental.

Before closing this report, permit me to offer a few general observations—first, as to certain defects in these International Exhibitions; and, secondly, as to what seems necessary to promote still further the success of our manufactures. One prominent want I have experienced in examining the articles exhibited has been the absence of all practical information, and of any individual on the spot ready to give it, the Commissioners themselves being, in many cases, quite unable to give any assistance. Generally, no data is given as to quantities produced, nothing as to prices; and though, in some cases, the producers have sent invoices to the Commissioners, the prices so set down afford no guide as to the market value of the articles, since they are more fanciful than real. The catalogue, too, is very imperfect; and most disappointing it is to the inquirer and student to be able only to give a superficial glance at the objects, and to find them always sheltered by the unwonted restriction, "Ne touchez pas, s'il vous plait."

Defects of Exhibitions.

Absence of information.

It is, perhaps, a necessity in the case that the real condition of manufacturing industry in the different countries cannot appear from the few specimens exhibited. But if it be advantageous to impress our manufacturers with the sight of the advance made by other countries, it is still more important to put them in possession of the principal facts relating to the condition of such industry abroad, that they may study them for themselves at home. For this purpose it is all necessary to follow up such an exhibition with a careful and exhaustive survey of the economics of manufacturing industry, the rate of wages, the social and intellectual condition of the labourers, and any other items necessary for studying the relative power of the different commercial nations, to sustain the keen competition now existing between them. Even the exhibition of costumes, which shows the real wants of the people and the mode by which they supply themselves with articles of dress, suggests further and deeper inquiry, which can only be made upon real life in the countries themselves.

Temporary character and passing impressions.

Need of deeper study on the wants and habits of different people.

In concluding this report I would recommend:

First, that a commission should be issued composed of individuals possessing artistic, ethnological, chemical, and commercial knowledge, to examine and report upon the state of manufacturing industry in different countries in relation to the requirements of the masses of the people. A Committee of the House of Commons would not meet the

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case, as it would be impossible to obtain the necessary information in this country. And the reports of her Majesty's Secretaries of Embassy and Legation on the manufactures, commerce, &c., of the countries in which they reside, valuable as they are, are not sufficiently complete and technical for the purpose.

Secondly. Let works of the same character as that of Dr. Forbes Watson on the costumes and textile materials of India be produced from time to time for all countries, and communicated to our Chambers of Commerce and manufacturers, together with collections of samples of textile materials woven and produced in such countries.

Thirdly, having regard to the temporary character of such exhibitions, their advantages can best be extended by enriching our museums, extending our galleries, and exhibiting to the masses of the people not only models of art and design, but whatever may interest them regarding the condition of life and intelligence all over the world.

Lastly, as regards artistic instruction, it has been my duty to report that in the classes I have more especially examined Great Britain seems somewhat deficient in inventiveness and design. Thirty-one years ago, in the Session of 1836, a Committee of the House of Commons was appointed to inquire into the best means of extending a knowledge of the arts and of the principles of design among the people, especially the manufacturing population of the country; and it is singular that even then this deficiency was particularly manifested in the very branches I have reported upon. A high authority, Dr. Playfair, has just suggested a careful inquiry into the schools of art and design in other countries, and I can only bear my testimony to the necessity of such an inquiry as an important branch of that which I have suggested into the state of manufacturing industry. Let us give due heed to this salutary warning, and endeavour to extend with all possible speed science and art among our working population.

Great lessons and untold benefits are derived from undertakings of so vast a character as these international exhibitions, and not the least of them are the various suggestions to which they give rise, and the impetus they give to the permanent progress of industrial art in all countries.

# Report on Lace, Net, Embroidery, and Smallware Manufactures.—(Class 33.)—By Mrs. Bury Palliser.

Mrs. Bury Palliser on Lace, Net, &c.

## 1. Lace.

The excellence of lace making can only be appreciated by those who are acquainted with the difficulties of its manufacture. The laces of Alençon and Brussels are of so complicated a nature that each process is assigned to a different lacemaker, who works only at her special department. Formerly a piece of Alençon lace would pass through eighteen hands before completion; the number is now somewhat diminished.

Lacemaking. Its difficulties.

The black shawls and flounces of Bayeux are all made in small lengths, and the task of uniting these segments by an invisible seam is one requiring great skill and precision.

Again, Valenciennes lace is of most elaborate workmanship, the pattern and ground are made together with the same thread on the same pillow. One exhibited with the lace in progress has no less than 1,200 bobbins.

The great improvement to be observed in the manufacture of lace is the introduction of shaded tints in the flowers and patterns, giving them the relief of a picture. This effect is produced by varying the application of the two stitches used in making the flowers, the "toilé" which forms the close tissue, and the "grillé" employed in the more open part of the pattern. The system is succesfully applied to the laces of France and Belgium, but it is in France that it has been adopted with the greatest success.

Progress of manufacture.

The exhibition of French lace is of the highest order, and its most celebrated fabrics are worthily represented. Alençon point maintains its historic reputation; the black pillow-lace of Bayeux is unrivalled in elegance and beauty.

French lace.

The manufacture of black lace, which extends through the department of Calvados, and is carried to the greatest perfection at Bayeux, has now entirely superseded the extinct fabric of Chantilly. The manner of making both laces is the same, and the so-called Chantilly is the production of Bayeux. It is now the most important of the lace manufactures of France, and is unequalled in beauty of design and excellence of workmanship. (*See* Figs. 1 and 2, p. 123.)

Black lace of Calvados.

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MM. Lefebure's Alençon point.

Messrs. Lefébure (57) exhibit a splendid collection of the varied products of their fabric at Bayeux. Among those most deserving of attention is a dress of Alençon point, consisting of two flounces, Fig. 2, and trimmings. The festooned border which surrounds the groups of flowers and foliage is shaded so as to give the effect of being fluted. The design is of great beauty, and nothing can surpass the regularity of the ground or the variety of the open stitches. The price of this dress is 85,000f. (3,400*l.*), and it took forty women seven years to complete. Departing from the old custom of giving to each lacemaker a special branch of the work, the Alençon point of Messrs. Lefébure's manufacture is begun and finished by the same workwoman. The "Pointe," or half shawl, of Messrs. Lefébure is the most effective specimen of black lace in the Exhibition. The pattern, designed by Mr. Alcide Roussel, the special artist of the house, consists entirely of roses. A border of roses surrounds the shawl; and a large bouquet, most elegantly grouped, forms the centre, all exquisitely shaded and standing out in bold relief from the ground, which is perfectly clear, devoid of those small stars, spots, and other accessories called "ornaments" usually placed to conceal the seams that unite the segments of lace, but which destroy the general effect. The price of the shawl is 10,000f. (400*l.*)

There is great beauty in the design and excellence in the workmanship of a bridal veil or "rotonde" of mixed fabric. The ground is needle-point; the flowers application, made at Ghent; a scroll border, in the style of Venice point, surrounds the veil, and ornaments of Alencon point are introduced.

Messrs. Lefébure also exhibit the lace of Malines or Mechlin; and they have been most successful in reproducing the ancient "Rose," or Venice point in high relief. The raised flowers are executed with great beauty, and are surrounded by a pearl, or "picot." of geometrical regularity. The discovery of the way in which this richest and most complicated of points was made has been the work of great patience and intelligence. The reproduction is styled "Point Colbert," in honour of the Minister to whom France owes the foundation of her lace industry. (Fig. 3.)

Point Colbert.

Of the black laces of Bayeux (3) there are many excellent specimens. They form the principal feature in the French exhibition. Among them may be mentioned—

MM. Verdé Delisle.

Messrs. Verdé-Delisle (Compagnie des Indes) (4) have a flounce of ferns, iris, and various flowers, beautifully shaded and on the finest ground; and a dress of similar pattern, of great elegance, but less fine in quality.

They also exhibit a parasol, with ground of extraordinary fineness; and their black lace "Pointe" may be placed by that of Messrs. Lefébure: the shading of the flowers is perfect, the grouping admirably light and well composed. In beauty and correctness of design these two houses far outstrip all others. Each has its own artists; the pattern, when made, is the subject of consultation and criticism, in which the heads of the firm, draughtsmen, and workers, all take their part. It is often the result of years of study; hence the perfection to which they have arrived. These patterns have also the advantage of being the special property of the house, and are therefore not reproduced in ordinary or machine-made lace, as we observe to be the case where one artist works for the many.

Other French exhibitors.

Messrs. Verdé-Delisle also exhibit a magnificent flounce of Alençon point—the pattern, style Louis XV., bouquets of flowers in medallions. Their dress of Brussels mixed points (points mélangés) is very elegant and effective, and of exceedingly low price (150*l.*) In the ecclesiastical court, in the garden, they have also some good specimens of Cluny guipure, a chasuble, with the lamb and other attributes in raised work; and some altar-cloths executed in the same style.

A Bayeux flounce, rose-patterned of M. Pagny (7), may be classed among the finest specimens of black lace; and Bonnet (6) has a fire-screen (écran) style Louis XV., and some fans of graceful design.

A black lace shawl of M. Lecornu, of Caen (11), is fine and well executed, but too complicated in pattern for artistic beauty.

Messrs. Aubry (8) exhibit a black lace flounce, a specimen of the extreme fineness that the ground may be made to attain. It is technically called "réseau quarante;" that is, it contains forty stitches to three quarters of an inch (two centimetres) square. Their black parasol is also of remarkable workmanship, the flowers being shaded by the dexterous introduction of a coarser thread upon the pillow, so as to resemble embroidery. It was made at Viarme, near Chantilly.

Messrs. Aubry have likewise a magnificent tunic or dress of white lace, the joint production of Brussels and Mirecourt (Vosges); needle-made ground, with raised ornaments and flowers superposed. Their coverlet of Cluny lace, with raised flowers, is also of great merit.

Lace of Auvergne.

Le Puy, Crâponne (Haute Loire), and the other fabrics of Auvergne, exhibit no novelty in their manufacture. Black silk guipure shawls, "dentelles de laine," poil-de-chèvre,

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laces printed in colours, or embroidered with pearls, little varying from previous exhibitions. The success of the Cluny lace (first copied by a manufacturer of Le Puy from old laces in the Musée de Cluny, whence it derives its name) was an injury to the lacemakers of Auvergne and Lorraine, as it led them to forsake their old industries for an article of ephemeral demand. The fashion for Cluny lace has passed away, a circumstance not to be regretted, as the stiff patterns and heavy fabrics of the sixteenth century are but poor substitutes for the graceful and delicate productions of more modern times.

The handkerchiefs, with borders of Venice point and "filet," made in the convent of Notre Dame du Puy (64), are worthy of notice as being most elaborate reproductions of the old fabrics. Gandillot's (58) "guipures d'art" are admirable, as are also those of Violard (60); and the filet of Mdme. Pessière, in class 91, is worked with much accuracy and in great variety. Warée (34), Mirecourt, has pillow-made guipures for coverlets and objects of toilet of excellent workmanship.

In a collection so varied and so splendid it is impossible to designate all.

Pre-eminent skilfulness and good taste of French production.

The exhibition of French lace is only rivalled, but not surpassed by Belgium. This superiority is to be ascribed not only to the skilfulness of the lace workers and the finish and perfection of their work, but most of all to the perfect taste which characterises the productions of France, and is one of the great sources of her industrial richness.

Exhibitors of Belgium.

Belgium has a magnificent display of its varied manufactures—Brussels, Valenciennes, and Grammont, to which must still be added Mechlin, the prettiest and lightest of its fabrics; but the fashion for it has died away, and there is little made at the present time. The lace is all laid out upon a lilac ground—a colour peculiarly adapted to set off the dazzling whiteness of Brussels lace.

Brussels point.

The different kinds of Brussels lace, "point à l'aiguille," and "plat," the production of the pillow, are worked with that unrivalled delicacy and precision which have given to Brussels its world-wide celebrity.

Among the most remarkable specimens exhibited may be noticed a half-shawl of Normand and Chandon (70) in point à l'aiguille, with convolvulus pattern of great beauty; and another of Verdé-Delisle (79), with guelder roses, ferns, &c., and flounces to match.

In Brussels lace the plat, or pillow-made flowers, are "applied," or sewn upon a ground of Brussels net. Of this kind, called "application" (70), Normand and Chandon

(house, Frainais and Gramagnac, of Paris) have a superb bridal-veil; Verdé-Delisle a half-shawl, with bunches of lilac—nature itself; and Hoorickx (55) another, that has not been whitened, of fine workmanship. Mrs. Bury Palliser on Lace, Net, &c.

The special excellence of this last-mentioned house is "point gaze," of which a dress is an elaborate specimen; the point gaze is worked with great evenness and clearness, and the open stitches with great elegance, but, as a whole the effect is monotonous and the flowers crowded—a common fault in the Brussels patterns. The price of this dress is 50,000f. (2,000*l*.) Two fans (point à l'aiguille) are of most graceful design, and a lappet, with raised flowers, is deserving of notice.

Van der Smissen (74) exhibits application and point, made at Alost, of great freshness and whiteness.

Van Loco (76) has a collection of Mechlin lace from Turnhout (province of Antwerp), one of the few places where this fine effective lace is still fabricated. Mechlin.

The manufacture of Valenciennes lace, after dying out in its native city, was transferred to Belgium, where, from its commercial importance, it forms the principal branch of the lace industry of this country. It is fabricated throughout East and West Flanders. That made at Ypres (West Flanders) is of the finest quality, and most elaborate in its workmanship. It is remarkable for its clear square ground and its improved patterns. In case 52 is a magnificent display, the collective exhibition of all the manufacturers of Ypres, among whom M. Duhayon Brunfaut, who first introduced improvements in the ground and patterns, holds a high rank. Courtrai (West Flanders) has made great advances towards rivalling Ypres, as the laces (69, 73, and 75) will show, and has produced the first half-shawl ever made of Valenciennes lace, exhibited by Verdé-Delisle (79). Valenciennes, principal lace industry of Belgium.

The black lace of Grammont (East Flanders) shows great improvement—the ground firmer, the patterns executed with greater precision, the silk of the best quality. The productions of Mdme. Everaert (5), after French designs, are of good pattern and fine quality. There is a large display of shawls, the collective exhibition of the manufacturers of Grammont (6 to 51), among which it is difficult to select. Those of Van Caneghem (42), Deschauwer (19), and Van Belleghem (39), may he distinguished; but the fault of the Grammont fabric is its heaviness of pattern, which will prevent it, except in cheapness, from competing with the more elegant productions of Calvados. Black lace of Grammont.

Another defect in the Grammont lace is in the workmanship of the leaves. The fibres, instead of being rendered

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(as in the Bayeux lace) by a silk with a kind of open "grillage," worked on each side to give it relief, is expressed by a simple silk thread, which gives a naked, unfinished appearance to the large leaves of which the Grammont patterns usually consist.

After the productions of France and Belgium, there is little to admire in the lace exhibition of other countries.

Prussian and German States.

Prussia and the states of Germany exhibit no lace, with the exception of some needle-point flounces from Berlin (12), and the coarse pillow-edgings of Nurtingen, in Wirtemberg (Robeck, 5), where the lace industry has greatly extended this last 15 years. Austria has a "Point Imperiale," and some coarse laces of the Bohemian peasantry.

In Spain the lace of Barcelona hardly sustains its old reputation, and the patterns are losing much of their national character.

Sweden has the "torchon" lace of the Dalecarlian peasants; Russia that of Helsingfors, in Finland.

In Italy is a large exhibition of the black and white pillow-laces of Genoa, poor imitations of Chantilly and other French fabrics, and from Rome is a magnificent example of old Venetian point, of finished workmanship which belongs rather to the Retrospective Collection.

Turkey exhibits specimens of a white silk crochet lace, made at Smyrna and in the island of Rhodes. This work, called "oyah," is also executed in colours, forming flowers and figures standing out in high relief from the ground.

Malta has her black and white guipures, of the old stereotyped patterns.

England.

Honiton lace.

In England the Devonshire lace is irreproachable in execution, as will be seen in the elaborate half-shawl of Mrs. Treadwin of Exeter (32), and in various specimens of Honiton lace exhibited by Mr. Biddle (5), by Miss Radford (29), of Sidmouth, and others. Mrs. Treadwin has been very successful in her imitation of the vandyked collar-lace of the time of Louis XIII.; and Miss Jones (19) has sent a needle-made flounce of most creditable workmanship. Bedford now employs her pillows in making Cluny flounces. Ireland varies little from her usual productions. One of the best specimens of Irish guipure is exhibited in the French Court, a coverlet of beautiful workmanship. It is in the case No. 34, belonging to Warée, of Mirecourt, who has also a lace fabric in Ireland. While we assign to our lacemakers every merit for the beauty and precision of their work, we lament to find so little improvement in their

patterns—universally heavy and crowded; and when we see (18) ostriches and giraffes introduced upon lappets, and lions and eagles upon cuffs and collars, we can say little for the amelioration yet effected by the establishment of schools of design.

Lace museum at Le Puy.

In Auvergne a lace museum, "Musée de Dentelle," has been established at Le Puy, containing specimens of the lace of all countries and of all ages. Surely a similar institution might be founded with good effect at Exeter or some other centre of our lace manufactures. There is no teaching like the teaching by example; and an acquaintance with the elegant productions of other countries would best lead our lace makers to see the deficiencies in our own.

South American states.

The Republics of Central and South America show indications of lacemaking. In the costume of the Guachos, exhibited by the Argentine Confederation, the linen trowsers are ornamented with a broad border of "filet" or drawn-work. Uruguay has a scarf of the same workmanship. Chili sends a collection of the coarse lace of the old lozenge pattern made by the peasant women of Santiago, and men also appear to work at lacemaking in that province. Venezuela exhibits the finest specimens of this drawn-work lace in some infant's caps and borders of pocket-handkerchiefs, works of great patience and ingenuity, but which come more under the class of embroidery. The finest specimens are from Caraccas. The lace-bordered handkerchiefs of Brazil are of similar workmanship.

## 2.—Net and Machine Lace.

Net and machine-made lace.

Nottingham and Saint Pierre-lez-Calais are the principal seats of the bobbin net and machine made lace manufactures. Since the application of the Jacquard cards to the making of lace both fabrics have produced imitations of very great beauty, and at a very low price.

Nottingham and Calais chief centres

The Calais manufacturers exhibit imitations of every kind of lace, cotton, silk, and mohair; Valenciennes, Cluny, coloured laces, blondes white and black, silver and gold. Their Valenciennes is excellent; but the most marked progress is in the perfect imitations of white silk blondes, nearly approaching in whiteness and brilliancy the famed productions of Caen, which, by their cheapness they are fast expelling from competition. Lefort (26), Bacquet (56), and Le Comte (28) have magnificent white and silver blondes and Brunot (40) a dress of white blonde made in a single piece.

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Lama and yak shawls.

The finest lama and yak shawls are manufactured at Amiens, the mohair being imported from Bradford, in Yorkshire. The specimens of yak exhibited by Mr. Dognin (3) are remarkably fine in quality, and of good design, and mark a wonderful progress in this class of production. He terms the fabric "Dentelle des Indes." Lyons is the centre of the manufacture of plain and embroidered silk tulles and shawls. These products are exhibited with the silk tissues of that city (class 31.) Among these the collection of Mr. Baboin (31,240) is the most remarkable. The "tulle diamant" of Messrs. Agnellet, of Paris, is a sparkling and elegant material for dresses and bonnets.

Brussels net now replaces the pillow ground.

The tulle industry of Belgium consists in its Brussels net, now brought to the greatest perfection. Formerly the Brussels flowers were applied upon a pillow ground made of thread which has cost as high as 400*l.* the lb., and producing the finest and lightest tissue that can be imagined. The invention of Brussels net has superseded the use of this expensive ground, which few workers now know how to make, and has thereby materially decreased the price of Brussels lace. In No. 80, the widow of Mr. Washer, its original inventor, exhibits the Brussels net in its different stages of manufacture. The English cotton of which it is made (670) cost 44*l.* per lb.

The manufacturers of Nottingham exhibit little novelty. The black lace shawls and flounces rival those of Lyons; and the Valenciennes edgings and insertions of Packer and Manton (24) and of Jacoby (16) are equal to the productions of Calais.

### 3.—Embroidery.

Embroidery.

Of works in embroidery we have the specimens of every nation, from the gorgeous productions in gold and silver of the East to the humble moose-hair and porcupine-quill decoration of the Canadian Indian.

Embroidery may be ranged under two classes—white embroidery applied to dress and objects of furniture; and coloured embroidery, comprising works in silk, worsted, gold, and silver, for dress, furniture, and church vestments.

#### White Embroidery.

White. Principal places of manufacture.

White embroidery is executed by hand and by machinery, with the needle and the crochet-hook, on the fingers and on the tambour frame, which last was originally brought from China.

It is carried to the greatest perfection in France, Switzerland, Saxony, Scotland, and Ireland.

In France, the finest embroidery in satin-stitch (plumetis) is produced in the ancient province of Lorraine, at Nancy (Meurthe), and at Mirecourt, in the department of the Vosges. Tarare (Rhône) is celebrated for tambour or crochet work, principally employed for curtains. The specimens of the delicate and elaborate embroidery of Nancy and Mirecourt are exquisite. Among the most remarkable is a morning dress (peignoir) of Lachez-Bleuze (135), Nancy, with rich embroidery of ferns, convolvulus, and wheat-ears.

Embroidery of Lorraine.

The shirt-fronts and pocket handkerchiefs of Husson (137), of Féron (92), and Chapron (136), are most perfect in workmanship, and nothing can exceed the beauty of the "point d'armes" and other stitches in the cushion-cover of Lallemant (139), embroidered for H.M. the Queen of the Belgians, and a "guèridon" or stool cover worked by Horrer (138), of Nancy.

Driout and Moret (134), exhibit, from Mirecourt, a fire-screen, "écran." The subject, a group of goats, is a perfect example of the effect of light and shade, given by varying the stitches and superposing them several times over each other. The lights are expressed by satin-stitch, another kind of stitch produces the middle tints, and a third the shadows. There are pocket-handkerchiefs embroidered after the same manner, but the beautiful shading disappears on being washed. Driout and Moret have fabrics in the departments of the Vosges, Meurthe, and Moselle. That at Manoncourt (Meurthe) is for machine-made embroidery.

Juglar (89) has insertion and strips of embroidery upon cambric muslin, resembling the Scotch embroidery—"broderie Anglaise," as it is called by the French. The designs are excellent and the work good.

The best machine-made embroidery is that of Gilbert (129).

Lace curtains of Tarare.

Embroidery, as applied to furniture, has made great progress since the last exhibition. In the salle No. 10, class 27, is the collective exhibition of the town of Tarare, the rival of St. Gall and Glasgow for plain muslin, and without a competitor for its tarlatane and its embroidered curtains. In that kind of curtain, placed straight over the window, called by the French "stores," the pattern is displayed to the greatest advantage. Those exhibited are remarkable for their rich, light, and elegant embroidery, and beautiful design. Some are real pictures. Ruffier-Leutner (184), one of the most celebrated houses for this fabric, exhibit a good example of the application of art to industry in a curtain, (Fig. 4.) styled the "Fête des Fleurs," a beautiful composition, of excellent execution,

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and not of that extravagant cost as to make it unremunerative in a commercial point of view; the great object is to produce works of good taste at a moderate price. Another of the curtains has the arms of the city of Paris; and a third, style Louis XVI., with Diana and the emblems of the chase, is equal in richness of design to the Fête des Fleurs.

The curtains of Meunier (185) are also of most artistic design and careful execution. Two, style Louis XV., with pastoral subjects are deserving of special notice.

Among many others are also to be admired those of Brun (186), David (206), Victor Dubois (187), Deschamps (189), Lepelletier (210), and one in colours, by Larivière (212).

Switzerland. St. Gall and Appenzell.

Switzerland, the great competitor of France in white embroidery, has a most splendid collection.

This industry was introduced into the canton of Appenzell, in the last century, by a lady who had learned the art in the Levant. St. Gall is the commercial centre of the manufacture. The Swiss work is of the first rank and of a low price.

The pocket-handkerchiefs and shirt-fronts of Staeheli-Wild (21), St. Gall; the embroidery on jaconet, the petticoats especially, of Baenziger (Appenzell); and the insertions and bands executed by machinery of the last named, and of Rittmeyer (18), and Sennhauser (20), both of St. Gall, are worked with the greatest clearness and precision.

But the crochet curtains embroidered upon net form the most important branch of Swiss embroidery.

The "monumental bed" of Schlaepfer-Schlatter (19), St. Gall, is most effective. Altheer (2) Appenzell has a curtain of good design; another representing the Chateau of Arensburg. Alder and Meyer (1) have a flower vase, with arabesque medallion; that of Ranch and Schæffer (17) is powdered with flowers—all of excellent workmanship, but wanting in the purity and lightness of design of their French rivals.

Saxon embroidery.

With Saxony may be associated Wirtemberg; their productions are similar, and both are known in commerce under the common name of "Saxon embroidery." It was in Saxony the fabrication of white embroidery began, about a century ago, whence it extended to France, Switzerland, and Scotland. The work is confined to the mountainous regions of the Erzegebirge and Voïgtland, and is now in full activity, the girls being taught embroidery in schools under Government inspection.

Plauen, Eibenstock, and Annaberg are the great centres

of fabrication in Saxony; Ravensberg, in the kingdom of Wirtemberg. MRS. BURY PALLISER ON LACE, NET, &c.

Schnorr and Steinhausen (22, Room 27, Prussia) exhibit from Plauen a wonderful specimen of embroidery—an infant's robe in the finest satin-stitch, the pattern (bunches of roses with leaves in full relief) attached to the muslin ground only by the stalks. Bab (1) has handkerchiefs embroidered with raised flowers, and those of Mammen (23), with the infants' robes of Böhler (20) and the machine-embroidered petticoats of Jahn (21), all display the high excellence of the industry in Saxony.

Frünkorn (2), Wirtemberg show the produce of their manufacture near Ravensburg—curtains embroidered by machinery, at very low prices.

The white embroidery exhibited by other countries is scanty. Spain does not send the beautiful cambric of pine-apple thread from Manilla, embroidered with a perfection equalling any European manufacture. Other countries.

Sweden has some well embroidered handkerchiefs from Lund, and Italy various others of good workmanship but nothing approaching in excellence to the produce of France and Switzerland.

Most to be remarked in Italy are the "macramé," or towels, made at the Albergo dei Poveri, at Genoa, with long fringes plaited in geometric patterns of great ingenuity.

There is no Scotch or Irish embroidery exhibited; but some embroidery upon cambric muslin is sent from Bengal, worked, like the Scotch, with great regularity.

It is difficult to decide whether to class as lace or embroidery the elaborate workmanship exhibited by Persia in the veils worn by the women when they go out of the house. The veils, which are of cotton, have an aperture for the eyes, about 4 in. long by 1 in. wide, of the finest lace on drawn work, imitating the open-work stitches of Brussels or Alençon lace.

In white embroidery, France holds the first place. Switzerland can rival her in the quality of the work; and both that country and Saxony surpass her in cheapness; but neither can equal her in elegance of design or excel her in the perfection of workmanship.

## Coloured Embroidery.

From the East we derive the most elaborate specimens of coloured embroidery, as applied to dress and furniture. The rich works in silver and gold of Europe are more specially dedicated to ecclesiastical ornament, and court or Embroidery, coloured, of the East.

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military costume. Turkey, Egypt, and Morocco, ancient seats of Eastern luxury, cover with embroidery every article of domestic use.

Of these Turkey sends a gorgeous collection—slippers, purses, tobacco-pouches, caps, handles for hookahs, housings for horses, all in the richest embroidery of silk, gold and silver upon velvet and other tissues. Some covers for coffee tables and portières for doors are embroidered upon cloth. The Albanian costumes are one mass of gold.

A violet velvet carpet for prayers and one of lilac velvet with gold scroll and silver border are among the choice specimens exhibited by the Viceroy of Egypt, together with a cloth covered with large characters in gold and silver and housings superbly embroidered.

In Morocco is a variety of stools or cushions, and a large piece of red and black cloth, all embroidered with gold.

China and India are no less skilful in embroidery, but vary little from their primitive type. The Chinese, patient and laborious, execute, with twisted or floss silk, embroideries of the greatest accuracy. The Imperial dragon, embroidered in gold on crimson satin, and flowers and birds executed on white or coloured silk or satin, have, from the extreme care and cleanliness given to the work, a freshness and beauty unsurpassed.

The Indians embroider with great lightness and regularity. In the collection from Bengal are the delicate silk-embroidered net shawls of Delhi, muslins embroidered with beetles' wings, bags (joolee) of gold from Agra, the shubgara or coloured silk gauze shirts embroidered with gold from Central India, shawls embroidered with gold from Bombay, fans, saddle-cloths, &c.

Russia produces some fine specimens from Tiflis, a sofa-cover, pillows, and bolsters (9), embroidered in gold, and coloured silks upon crimson velvet, designed in good taste, and executed with that skilfulness of work for which the Georgian women are celebrated.

Roumania exhibits, from Bucharest, the leathern cloaks and vests of the national costume, gaily decorated with coloured worsted embroidery.

Canada sends tobacco-pouches, slippers, boxes, and various articles embroidered with moose-hair and the quills of the porcupine.

Church embroidery of Lyons and Paris.

The military and church embroidery of France is mostly executed at Lyons and Paris, and is the first of its class.

The vestments of Barban (110), Lyons, are of great magnificence; a chape of silver tissue embroidered with gold, and a chasuble of gold tissue, with figures in high

relief, enriched with jewels, are among the finest specimens in the Exhibition. MRS. BURY PALLISER ON LACE, NET, &c.

Biais (65), Paris, exhibits a chasuble of cloth of gold, embroidered in gold, with vine leaves and wheat, and several others equally elaborate in the styles of different epochs.

Henry (31, 151), of Lyons, has church embroidery of the finest workmanship.

Melotte (60), of Brussels, gives but one specimen of his art—a velvet banner embroidered with gold.

Milan, so celebrated in the Middle Ages for the richness and perfection of her works in embroidery, exhibits (48), some fine church ornaments by Eugène and Giuseppi Martini —a chasuble of white satin embroidered with silk, the pelican in relief in gold, and many others. Of Italy and Roumania.

The ecclesiastical embroidery of Roumania is very rich. A large entombment, worked in gold, with the lengthened figures of the Byzantine school, bears great resemblance in character and style of workmanship to a similar subject (5) exhibited in the Russian Court. Brazil sends a well-executed church banner, the work of the inmates of the Foundling Hospital at Pernambuco.

Various are the smaller objects of embroidery, difficult to class.

In France, Mdme. Lefay (127) exhibits a tulle train embroidered with vine-leaves and grapes of gold, and another in green and gold, perfect in execution, but faulty in pattern. A tarlatane ball-dress embroidered with poppies, from Tarare, is well executed. Asselineau (101), two bands of coloured silk flowers upon white ground. Poiret (99), butterflies and flowers embroidered in coloured silks and wools upon a buff canvas he calls "Natte de Panama." Heilbronner (100) has works on canvas of great beauty. Henry (142) upon cloth styled "broderie Turc," and various excellent "ladies' works" and "filet." Richter (20), in Austria, has the best variety of ladies' works in the Exhibition—a cushion of black velvet with twist of gold and silk flowers, a chair, and numerous others.

Zelgar (20) exhibits a needlework picture of the Emperor on horseback, Italy, a portrait of Victor Emmanuel, historic paintings, pictures to imitate engravings, &c.—all works of meritorious patience, but of little interest or utility.

### 4.—Smallware Manufactures.

Called by the French passementerie, comprising every kind of trimming for dress, furniture, and liveries, carriage lace, Passementerie.

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gimp, buttons, cords, &c. This industry is in great prosperity, and employs a large number of women and children. It is made by hand and by machinery. France is the principal centre of its manufacture and the only country which sends a large collection to the Exhibition.

The carriage and livery lace of Cagnet (123) are the best of their class. The epaulettes and gold-lace embroidery for military uniforms of Truchy and Vaugeois (68) are first of their class; and the tissues in gold and silver, for furniture, of Louvet (71), Passementier to the Crown, make a brilliant show of well-arranged colours. Alamaguy's passementerie is of remarkable beauty (81); that of Weber (69), is to be remarked, with the subject in passementerie of Adam (70), the buttons of Najean (76), and those of Pariot Laurent (79), with many others. Mottet (75) has some effective trimmings with glass beads.

In Prussia is some well-shaded carriage lace by Scharf (5); and the passementerie exhibited by Drachster (5), in Austria, is good.

The military gold lace of Bavaria, and that of England Davies (8), are of excellent workmanship.

Fig. 1.—BLACK LACE OF BAYEUX.

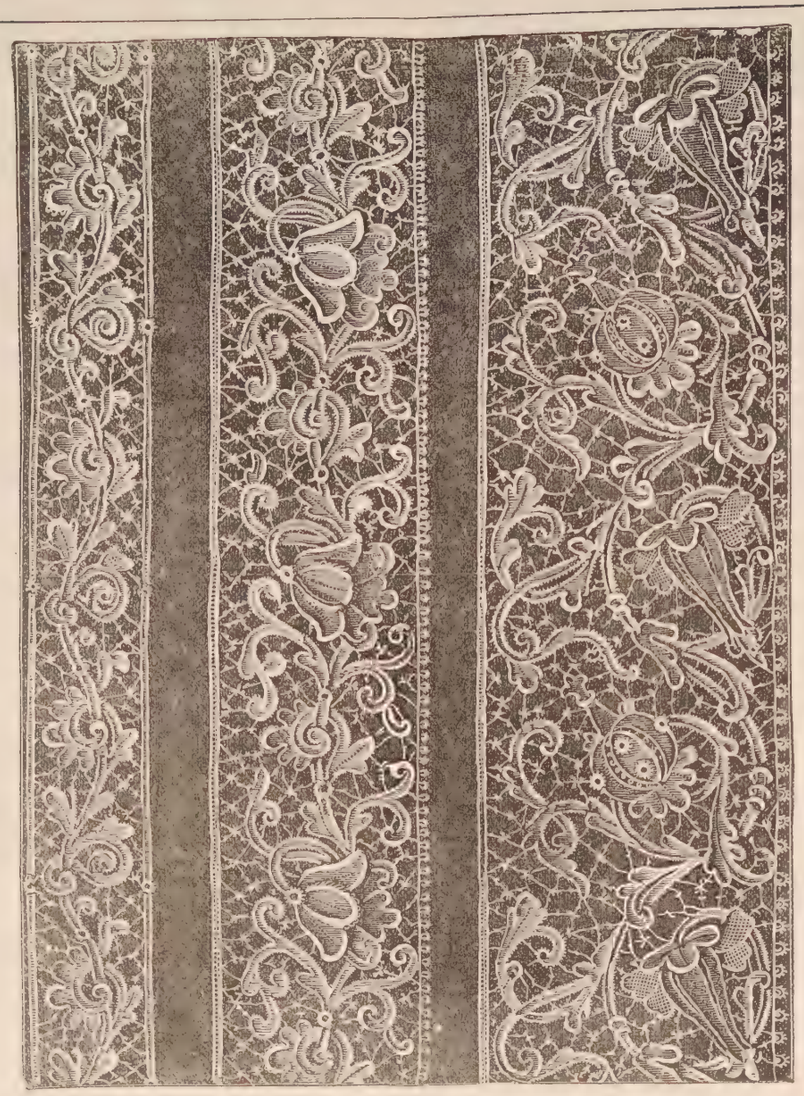

Fig. 3.—POINT COLBERT, A REPRODUCTION OF VENICE POINT LACE.

Fig. 4. EMBROIDERED CURTAIN OF TARARE.

Fig. 2.—ALENÇON POINT FLOUNCE.

## Report on Toys.—(Class 39.)—By G. C. T. Bartley, Esq.

Mr. Bartley on Toys.

The collection of toys in the Paris Exhibition is not a fair representation of the state of this trade at the present day; there is almost a total absence of ordinary and practical playthings. Great attention has been paid to dolls and mechanical toys, more particularly in the French Court. The German States do not send so good a sample of their great trade in these juvenile articles as might have been expected. Altogether, it is to be regretted that the subject of toys has not received the attention which it deserves.

How represented.

The following countries exhibit. The figures in the first column indicate the number of exhibitors of toys; those in the second the number of exhibitors of games; and those in the third the number of exhibitors of articles grouped with this class, which cannot be considered either toys or games:—

Number of exhibitors from each country.

| | | | |
|---|---|---|---|
| France | 23 | — | — |
| Holland | — | — | 1 |
| Prussia | 7 | — | — |
| Baden | — | — | 1 |
| Wirtemberg | 3 | — | — |
| Bavaria | 8 | — | — |
| Austria | 2 | — | — |
| Switzerland | 3 | — | — |
| Spain | — | 1 | — |
| Denmark | — | 1 | — |
| Russia | 2 | — | — |
| Turkey | — | — | 2 |
| Egypt | 1 | — | — |
| Tunis | — | — | 1 |
| Morocco | 1 | — | — |
| Japan | 1 | — | — |
| United States | — | 1 | — |
| Great Britain | 1 | 5 | — |
| English Colonies | — | 1 | 1 |
| Total | 52 | 9 | 6 |

In the following pages a brief outline is given of the merits of the exhibits of the various countries.

### France.

French dolls.

France has the largest number of exhibitors, and all, with one or two exceptions, reside in Paris. The most important French toy is undoubtedly the doll, and hence the visitor is not surprised to find that it is the chief article

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in the cases round the attractive, though crowded and confined, French Toy Court. The manufacture of these puppets is carried on in Paris to a greater extent than in any other city in the world; and as regards magnificence of attire and display of fashion, nothing can approach the French doll. To English feelings such a display is not an advisable way of educating the mind of a child; and, if a doll is to represent a baby, it is absurd for it to be dressed in all the grandeur of a full-grown and fashionable woman. At the same time, it must be borne in mind that the French doll manufacturers have an object in thus dressing their dolls, which is more important than their use as toys. They are sent to India, and all parts of the world, to serve as types and models of the Paris fashions; for on arriving at these places their first use is to be studied by the dressmakers; and, when useless to them in this respect, they descend to the children for toys. These two uses to which French dolls are subjected, though, perhaps, an economical commercial arrangement, are quite opposed to the production of a doll suitable for the hands of a child, and may account for the total unfitness of most of those exhibited in the French portion of the Exhibition to be classed as toys at all.

The manufacture of French dolls.

The manufacture is in itself a very interesting process, though difficult to witness, owing to the various portions being generally carried on in different places. M. Jumeau, at 8, Rue d'Anjou au Marais, is one of the largest makers in Paris. He employs many hands, the greater number being women, who are scattered in all parts of the city. The heads of his dolls are porcelain, and most of the bodies of sheepskin, stuffed with sawdust, except the hands, in which iron fittings are inserted, to enable the fingers to be moved easily. The process of cutting the leather is peculiar, being done by hand, with an iron stamp set in boxwood. The stamps, of course, vary in size, and several of different shapes are required for each doll.

When the leather is cut, the next process is to sew the parts together; this requires a regular apprenticeship, more particularly for the fingers, which need great care; after the various parts are sewn up, the body has to be stuffed and the limbs attached. The doll is then ready to receive its head; the manufacture of this part is totally distinct, and similar to that of ordinary porcelain. Cheap heads and shoulders are all in one piece, and their eyes are simply painted; while the superior description are made separate from the neck and shoulders, to enable the head to move on a sort of joint, and glass eyes are inserted into the sockets left for this

purpose. The last thing is the hair, and in this branch we much excel the French. At this manufactory, owing to the heads being of china, the hair has to be put on as a wig, and cannot be inserted so naturally as when the head is of wax. Human hair is rarely, if ever, used in Paris, the general material being mohair for the best and a sort of fur for the cheaper style of doll. The dolls, when completed, have to be dressed, and this process varies with the fashion; it would not do for a French doll to be behindhand in this respect. At M. Jumeau's establishment the same style is not used for more than a month. All the dolls' clothes are made on the premises, where a roomful of young women is continually at work for these small fashionables.

M. Jumeau's dolls.

The dolls exhibited by M. Jumeau are not his best specimens, nor can they be looked upon as giving a fair idea of his general style. Some of the smaller ones which are put in the less attractive parts of the stall are good. The three figures at the back of the case are got up in an elaborate and brilliant manner, representing ball costumes; but they are certainly not commendable as toys, or suitable to the taste of English mothers for their children. The small boxes of dolls' clothes, or the dolls' trousseau, are good toys, and from the variety exhibited, and the very large numbers manufactured, it is evident that they are popular.

Mechanical dolls.

M. Jumeau has not exhibited any of his mechanical dolls, saying "Mamma" and "Papa," and crying when laid down. These specimens are well worthy of a corner in the Exhibition. He also arranges the works, and dresses a large number of walking dolls, the patent for which is American, and for this reason he does not exhibit them.

Huret and Lonchambou's dolls.

Some of the dolls most fit for children are exhibited by MM. Huret and Lonchambon. The young lady in white on the right-hand side of their case is modest looking, and quite a child's doll. The dresses are well made, and there is no air of careless finish to be detected; all have the further advantage of being of gutta-percha, with articulated joints; by this they can be made to sit, stand, and move their arms in many positions. The doll's-house furniture exhibited in this case deserves mention as being among the best in the French Court. It is imitation inlaid wood, and though the finish, on examining the internal work, does not bear comparison with the best exhibited by Mr. Cremer, yet the patterns and style are commendable.

M. Rohmer's dolls.

M. Rohmer's dolls, in a case outside the Toy Court, are both well made and have pretty faces; the hair is not good or put in naturally.

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M. Au Bengali's dolls.

The finish of the collection of M. Au Bengali is not so perfect as those just mentioned; even the walls of the doll's-house in which the specimens are placed, though elaborately enriched, are made of wood so slovenly put together as not to be properly planed.

M. Rémond.

The case exhibited by M. Rémond contains a collection of gorgeously apparelled ladies. A bride is prominent in the midst, with a long train of white silk and orange-blossom; she is surrounded with fashion if not with beauty; some dolls using their eye-glasses, and others coquetting in imagination in a variety of attitudes, all, however, having a style which no one would care to encourage in a child. The novelty in this case is the carte-de-visite photographs of these young ladies. At first sight they might be mistaken for the portraits of ladies moving in the grandest sphere, but on a closer inspection the dresses and features of M. Rémond's group are recognized, and these magnificent persons are but the photographs of a few dolls. The same maker exhibits a well-arranged and nicely made doll's toilet table; the brushes, glasses, pomade-jars, jugs, basins, mirrors, &c., are so compact and tastefully placed as to make it an attractive toy.

M. Simonné's dolls.

In a very conspicuous corner outside the Toy Court M. Simonné has a case, and it is a pity that the space is not better filled. The dolls are stiffly arranged to represent a court ball. Some of the dresses are good, though the style is not at all pleasing. Most of the ladies' heads must have come out of the same mould; and the gentlemen's faces resemble one another in a remarkable manner. This show is grandly attempted, but the result is not happy.

Doll's clothes of Mdlle. Bereuse.

The doll's clothes of Mdlle. Beruse are among the best specimens of neat work and taste in this branch of the Exhibition; the case, in fact, being like a portion of a first-class ladies' outfitting warehouse; the various miniature articles of clothing are nicely arranged, and in every respect the collection is worthy of examination. The few dolls which are placed to show off the clothes are also greatly to be admired.

Mechanical French toys.

In mechanical toys the French greatly excel, and without doubt these form the most attractive and popular portion of the toy display. Everybody is at once taken with them, and, although the larger ones are not strictly toys, yet they serve as specimens of the great perfection which has been reached in adapting clockwork machinery to the delicate movements of the body. The large trophy is exhibited by M. Theroude, and some of the examples are remarkably good. A shepherd, near the top, almost life-size, is seated

Trophy by M. Theroude.

on a rock, and plays the flageolet, moving his fingers to the stops on the instrument, and, though this movement of the fingers has nothing to do with the formation of the varying sounds, all of which come from within the body of the man, yet the action is so natural that probably many persons would be misled. A very similar specimen, of a black man playing the flute, is exhibited below him on the trophy. He stands naturally, even gracefully, and the movements of the head and fingers are remarkably true, considering the number of joints, and consequent angles, through which the clockwork has to act.

The playing monkey.

The figure which, perhaps, most young people regard with the greatest attention is that of the large black monkey playing on the violin. This is very clever, for it really produces sounds with the bow, although the fingers of the left hand do not form the notes on the strings of the instrument, as some visitors have imagined. Its movements are easy, and at the same time comical; it turns its head, and opens and shuts its lips.

There is a smaller monkey, which sometimes is placed on the trophy. He is dressed in a glittering costume, and represents a dancing-master with his fiddle. His performances are even better than the former, as he leans his head on his instrument in the most absurd manner. He is well worth a visit: as also is the funny, little, smartly-dressed man playing at battledore and shuttlecock, who is a great favourite.

Besides these which are individually noticed, there are numerous small toys on the same principle exhibited by this maker, such as chickens running round and flapping their wings, dolls drumming as they ride along, dolls on horseback; goats, small monkeys, and hares all going through a number of evolutions.

M. Verdavaïnne's mechanical toys.

Another exhibitor of good mechanical toys is M. Verdavaïnne. His two organ men, one small and the other about 3 ft. high, are clever and amusing, as well as many of the small figures which are exhibited in motion on the table placed in the middle of the Toy Court.

M. Dessein's mechanical toys. Remarkable cheapness.

Amongst the mechanical toys must be classed those in tin, exhibited by M. Dessein. They are in several ways interesting, and worthy of remark. He manufactures a large number of toy railway engines and carriages, omnibusses, steam-boats, and metal articles used in houses. The prices are almost incredible—a train, without clockwork movement, consisting of locomotive, tender, and one carriage, all in separate portions and made to run quite evenly, is sold wholesale in a neat cardboard box for five sous, or two-

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pence halfpenny. The jury when examining these goods, could not believe that the articles were manufactured at the prices stated, owing to the value of the metal employed; but on examination it appears that, by an ingenious application of old biscuit-boxes and sardine-cases for the stronger parts of the toys not requiring painting, a fair profit is obtained even at these prices.

The process of manufacturing.

The manufactory of M. Dessein, at 13, Rue Chapon, is worth a visit for those who are sufficiently interested in seeing the whole process by which these tin toys are made. He employs about 50 workmen and women all the year round, and most of them are engaged at the manufactory. Some stamp out pieces of tin of various shapes by the thousand; others, by an ingenious machine, are enabled to fold these strips of tin into the shapes required at the rate of a thousand an hour; others cast the wheels and mould portions of the toys; the number and variety of these operations are surprising. When all the various portions are made they are transferred to the hands of more skilled workmen, whose business it is to solder the parts together. This is done with equal rapidity. Each workman has a tool consisting of a hollow handle, having a pointed piece of copper attached to one end of it, while to the other end two pipes are attached, one containing air and the other gas. These mix and issue at a jet close to the copper, and when lighted the Bunsen's burner thus formed plays on the copper and keeps it sufficiently hot to melt the solder. The workman, after having put the portions of the toy together and moistened them with a solution of chloride of zinc to make the solder adhere, touches a piece of the latter substance he has before him with the pointed end of the copper, and thus takes up a globule for use, the whole process very much resembling in rapidity and effect the sealing together with wax of two pieces of paper. When the toys have arrived at this stage of completion, the next process is to paint them, and this is done chiefly by women. They are first put into an oven, to make them capable of receiving the paint. The colours come chiefly from Germany, and are ground and mixed on the premises. The painting varies with the nature of the toys, some having several coats, and being finished off finely with a camel's hair brush: but the cheaper class necessarily receive less attention, and have only one coat. When painted they are again baked, and the colours thoroughly hardened. The last process, in most cases, is putting in the mechanical works, and this is done chiefly by M. Dessein himself. It, of course, requires considerable skill. The cheapest train, with locomotive, having clockwork movement, and capable

of running round a table, is (wholesale price) three francs fifty centimes, or under three shillings—this includes locomotive, tender, and two carriages, packed in a cardboard box.

Amount manufactured.

At M. Dessein's manufactory about 10,000*l.* worth of toys are made annually, entirely of tin, and considerable credit is due to this manufacturer for the ingenious utilization of various sorts of waste material. Many tons of tin are used, the new metal required being imported from England. It may seem incredible, but not less than a quarter of a million of toy trains, or a million of railway carriages, must be made at this one manufactory in the course of a year. A very large portion of them go to England.

Walking mechanical figures.

The mechanical figures with wheelbarrows holding flowers, exhibited by MM. Lamour and Roullet are novel and clever. These consist of a boy with clockwork inside him to enable his feet to move in the natural manner of walking. On being wound up he therefore walks along, pushing his barrow before him. It is a charming little toy, and to be regretted that so high a price has been put upon it.

Mechanical singing birds, by M. Bontemps.

*The Mechanical Singing Birds.*—In this display, all the articles of which are exhibited by M. Bontemps, there is nothing of special novelty, though the tunes sung by the various birds are very natural. One bird in particular, in a brilliant gilt cage, placed about the middle of the case, is an object of great interest; besides going through its warbling notes, it turns from side to side, and at the same time moves its head in a very birdlike manner. The price of these toys, if such they can be called, is of course high, and precludes them from general use. M. Bontemps is the only exhibitor, and it is due to him largely that these singing birds have been brought to their present perfection. The specimens exhibited are numerous, and embrace birds of different plumage and song.

Conjuring tricks by M A. Voisin.

*Conjuring Tricks.*—All those exhibited, with trifling exceptions, are by M. A. Voisin, who is a manufacturer of these articles. The tricks which are made in the greatest numbers are of the well-known character—such as the inexhaustible bottle, the egg-cup, the magic tree, &c. The trade and consequent manufacture of these articles—which, though classed with toys, can scarcely be said to come under the heading of either toys or games—appears to vary very much; it rises and falls according to the popularity of a clever wizard, and at the present time is not very flourishing in England.

Military toys, by M. Andreux.

*Military Toys.*—Those exhibited by M. Andreux are good, and no manufacturer equals him in finish or design—many being, in fact, quite models of guns and artillery.

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Miniature cannons and gun-carriages, swords, military equipments, and drums are the chief articles he makes, though he also exhibits ships, and tin toys moving by clockwork. This manufacturer has several places in Paris, and employs about 40 workmen of different kinds. The whole of them are paid by piecework, and the lowest wages are 4*s.*, the highest 10*s.*, a day. A great peculiarity of these toys is the number of pieces each contains when complete, considering the low price at which it is necessary to produce the finished article. Guns about two feet long, firing caps, well made and polished, are sold for a little less than 15*s.* a dozen. Now, in the lock alone there are eight distinct pieces of metal, all of which have to be cast, fitted, polished, and put together before the lock is made; this must then be attached to the stock by several rivets and nails, then arranged to suit the barrel; yet the whole, including the material, after passing through 10 hands, is sold for less than 15*d.* The workman who mounts the locks and barrels must finish at least 150 guns a day in order to gain a livelihood. The polishing of the various metal parts is done by steam, and the polishers (paid by the piece) obtain higher wages than any other workmen in the trade. The wooden stocks are polished chiefly by women. About 70,000 toy guns are manufactured at this establishment in the course of the year. The number of military toys has very much decreased of late years, the present notion being in favour of giving children toys more suggestive of the arts of peace.

The wooden gun-carriages made here are beautifully finished; all the best, as well as the superior guns firing a charge, pass through M. Andreux's hands for careful examination, in order to prevent a chance of accident. There is considerable fashion even in toys, as was particularly noticeable after the war last summer. At that time, every one being interested in the Prussian fire-arm, M. Andreux produced a toy needle-gun; and so great was his success that he sold 38,000 of them in three months. To produce some portions of the guns, and particularly the last-mentioned needle-gun, requiring short tubes with indentations of great exactness, to slide one within each other, very ingenious and expensive machines are used, which first cut the piece of iron into the required shape, and then roll it up in a most astonishing and rapid manner. The method and machinery employed in shaping the wooden stocks are, perhaps, the most curious part of the manufacture. It is all done by the circular watch-spring saw. A tree 20 feet long is first of all longitudinally cut in half, and the rough shape of the stocks is drawn on each flat side, as close together as possible. The

beam is then cut into the lengths indicated, and, with a rapidity that is almost incredible, the workman glides the block so that the saw cuts along the lines drawn on the beam. By this means the rough stocks are shaped out by dozens, one workman being able to produce about 500 a day.

Miscellaneous toys.

*Miscellaneous Toys.*—Only a few are exhibited, and the best of these are in the case of Messrs. Duvinage and Harinkonck, otherwise called "La Maison Alphonse Giroux." A Roman car, laden with arms and military implements, drawn by a yoke of oxen, is carefully made, and the oxen are fine creatures. It is a pity that there is no arrangement on their feet to enable them to be drawn along the floor. The woodwork of the car is well carved, as also the Roman soldiers standing by its side. Close to this is an elephant, likewise loaded with Roman soldiers, and really quite a zoological model. The same case contains other animals coated with skin equally good.

M. Dehors' metal toys.

The metal toys exhibited by M. Dehors, just outside the court, are very good. Knives, forks, dinner services, and every description of dolls' plate, both in metal and china, are to be seen here. Several of the specimens are in aluminium bronze; and these, from the beauty and gold-like appearance of the metal, are most attractive. A few of the moulds used in the manufacture of these articles are also exhibited. The little toilet services have great charms for children; they are so nicely made; and, though superior to most, are not quite so elaborate as some in the neighbouring cases. At the top of this stall, though so high as to be almost invisible from the reflection of the glass, is a set of remarkably good fur animals. It is a pity that they are so much out of sight.

M. Simon's miscellaneous toys.

The miscellaneous toys of M. Simon are certainly superior to his dolls already mentioned. The horses and jockeys are nicely made, also the military toys, including the soldiers' tent. A remarkable canteen is placed here, though its size and general arrangement make it more fit for practical use than for the imaginary requirements of dolls.

M. Schutz's moving toys.

The playthings exhibited by M. Schutz are different from all others in the Exhibition. They have some sort of movement, though not a clockwork one. This is managed either by the wheels setting parts in motion or by strings passing through the figures. A cart full of animals at the bottom of this case makes a capital toy. The animals can be taken in and out, and as the cart is pulled along a monkey goes through various comic evolutions. Every variety of figure is to be seen—dancing-men, monkeys, grotesque dolls, &c.; all are well finished and tastefully dressed. About the best toys here are two peasants made to represent hawkers, car-

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rying large baskets of household wares on their backs. These baskets can be packed and unpacked, and so form an amusing toy.

M. Rémond has a few miscellaneous toys, besides dolls, though these latter, as already stated, form the more important part of his case. A mechanical train is conspicuous, as also some fair carts, horses, and military toys. In the centre of the court is a round table, on which the prolific top exhibited by M. Caumière is continually spun by an attendant.

The prolific top.

This top is of Japanese origin; and the number and variety of ways in which it may be spun, and the skill required in spinning it, make it quite an attractive plaything, even to grown-up people. Amongst the French miscellaneous toys,

Cheap toys by various masters.

though placed in Class 91, owing to their cheapness, must be included the exhibits of the following makers:—M. Feliker, a collection of the cheapest toys, such as rough dolls, rattles, whips, &c.; M. Clavel, a number of wooden toys, such as cannons with large wheels, windmills, trumpets, &c., all quoted by the gross, at wonderfully low prices; M. Thael, animals made in plaster, of very original and grotesque shapes, evidently invented by the maker; M. Bunant, gutta-percha articles, including dolls, balls, rattles, &c.; and, lastly, a number of children's colour-boxes, of all prices and sizes, warranted to contain no poison. Little thumb-palettes, with half a dozen colours and a brush attached, sold for about 1½*d.*, are likely to be popular.

French games.

*Games.*—There are only one or two unimportant French games exhibited among the toys; and these are by M. Giroux, who has an elaborate display, in Class 26, consisting of a small cabinet with about a dozen drawers, all compactly filled with games, chiefly in ivory; the case forms an elegant piece of furniture; and, though there is nothing novel about the games themselves, the skill displayed in arranging so large a number calls for remark.

## Holland.

Holland.

The exhibition of toys from this country is trifling, and consists of eight coloured cardboard figures, made for the Indian Theatre. They are grotesque and comical, having rivet joints similar to the dancing donkeys so popular a few months back.

## Prussia.

Prussia.

The Prussian collection of toys is not so extensive as might have been expected.

Metal doll's house furniture.

Mr. Söhlke, of Berlin, sends an assortment of well-made metal toys, consisting chiefly of dolls' house furniture, such

as candlesticks, lamps, chairs, tables, stoves, and English fireplaces, &c. There are also boxes of metal figures, fairly modelled carts and horses, and a few military toys. Mr. Bartley on Toys.

The articles sent by Mr. Osius are entirely of fretwork; some of the little chairs, tables, pianos, and other pieces of dolls'-house furniture are beautifully made and worth noticing. Fretwork furniture.

M. Scheibner's collection of ordinary German toys has no novelty.

On the opposite side of the gallery are Mr. Kirschkamp's dolls; and although their finish is not equal to that of the French, yet they have a childish style which makes them more fitted for toys than their gaudy neighbours. Dolls.

The elaborate glass case of figures and animals sent by Mr. W. Simon, although in detail ridiculously out of proportion, deserves to be remarked. The animals in many cases, horses and cows (only up to the waist of the man leading them), are beautifully made, as well as the trees and buildings in the background. The toy, however, is too big and clumsy for use.

In another room will be found a small collection of glass marbles: these are made in enormous numbers and in an infinite variety of design. The process of manufacture consists in rolling a piece—or "cäne," as technically called—of coloured hard glass within a globule of soft transparent glass; the pattern varies with the colours of the "cänes" and the number of turns, &c., given to it during the process. Glass marbles.

## Wirtemberg.

There can be no question as to the very great superiority of the Biberach tin toys over all others manufactured, except as regards the prices, which are very much higher than those charged by M. Dessein, in Paris. Wirtemberg.

Rock and Craner's case is full of beautifully-modelled toys in tin, including every description of carriage, cart, cab, omnibus, perambulator, &c. On examining them one is struck with their firmness and solidity, and the evenness with which all the animals and carriages run. The former are now arranged with small wheels in those feet which touch the ground; this is a great improvement on the clumsy flat board set on wheels on which the horses used to stand. Great attention is paid to the mould in which the animals are made—the exact similarity of the four horses in the drag is to be regretted, but no fault can be found with their shape. English visitors will be struck with the Hansom cab, which is decidedly not a German toy; but at this and other manufactories in Germany, carriages, carts, &c., are often made Rock and Craner's tin toys.

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from models supplied by the large foreign toy-dealers for their own market.

Tin dolls' house furniture.

H. Blumhardt and Co., Stutgard.—The objects exhibited by this company are almost entirely dolls' house fittings. They are good, and have the great advantage of being firm and solid. The dolls' houses themselves are, of course, finished chiefly after the German fashion, and the stoves are rather out of proportion to the rooms; but in this case, as in that of Rock and Craner's, nationalities are studied for the various markets supplied.

Carl Gross, Stutgard.—This maker has a most miscellaneous collection of all sorts of wooden toys—horses, carts, stables, conjuring tricks, tool-boxes, and a few turnery goods. By the side of the bright tin toys these look rather rough; and in fact, there is nothing very remarkable in this overfilled and badly-arranged case.

## Bavaria.

Pewter soldiers.

There are eight exhibitors from this country, and a considerable collection of toys of different descriptions. The larger number are the well-known pewter toys shown by M. Hafner and M. Allgeyer. Both these exhibitors have sent a large number of soldiers of all nations. An Englishman will easily recognize the uniform of the Foot Guards by their red coats and bearskins. The variety of uniforms shows that the trade is pretty extensive, and made to suit the nationalities of different markets.

Coronation coach.

The most striking object in this class in the Bavarian Court is the coronation coach for the Emperor and Empress, exhibited by Mr. Birkman, of Nuremberg. It is drawn by eight horses, every part made entirely of metal, even to the reins and harness. On the roof are figures of fairies in wax, but badly modelled. The carriage is most elaborate, but is not to be compared to the perfection of those from Biberach exhibited a few yards off.

Magnetic fish, &c.

The toys sent by M. Issmeyer are mostly of tin, such as magnetic boats, fish, swans, &c. Some of these are well made, and as toys, are always popular with children.

The Swiss cottage exhibited by M. Finkh has many points to commend it, though rather large and clumsy. The animals are nicely modelled, and the peasants are in keeping with them.

Nuremberg shops.

One of the special manufactures of Nuremberg is that of models of shops; and those sent by M. Hacker convey a tolerable idea of a toy which is always in demand. Grocers' shops are the most popular, from their having a number of drawers which open and shut, and so give plenty of occupa-

tion to children. From photographs in this case, it appears that all sorts of shops are made to order. Those exhibited here as specimens are very elaborately got up. The pastry-cook's at the bottom, though one of the most attractive, is not so usable as the others.

Hunt and Hoffman's paper toys.

The paper toys of Messrs. Hunt and Hoffman, of Nuremberg, should be looked at. They consist of separate pictures of men, animals, carts, trees; each is painted on stiff cardboard, with a block of wood glued to the foot in order to enable it to stand easily. The position of the figures, &c., can be moved as desired to form different views, and to give scope to the imagination and ingenuity of the child.

Horn snakes.

The horn snakes of M. Wohlgeschaffen are good specimens of these curious toys. They are made with a particular-shaped tool in a lathe with considerable rapidity, and, consequently are inexpensive, although they appear of intricate workmanship.

Roulette games.

The games of roulette as exhibited by M. Xavier Wahlgeschaft, of Nuremberg, have not the finish and delicacy which one would expect from that maker.

## Austria.

Mechanical and other toys.

The case of toys sent to M. Liebscher is one of the most interesting in the Exhibition. His toys are chiefly mechanical, though totally different from those in the French Court; and most have a musical snuff-box concealed in them. One is made to represent Blondin crossing the high rope with a wheelbarrow. A little figure trundles the barrow across the rope while a tune plays. Another toy consists of a group of persons sitting round a piano; one of them beats time, another plays, others listen, and music is heard from the instrument. Ordinary toys are also exhibited, such as horses, carriages, animals, balloons, and dolls' house furniture in wood. Besides these, there is a collection of clockwork pictures. In one a schoolmaster flogs an urchin while a boy draws a donkey on the wall behind the teacher's back; in another three fiddlers play away and nod their heads; and in a third a balloon ascends in the background of an elaborate landscape.

## Switzerland.

Switzerland.

This country has three exhibitors. M. Rous's collection of dolls in Swiss costume is interesting, and the dresses are nicely made. On close examination, the visitor will find a beautiful model of a gun and gun-carriage, by M. Benoit, placed in the middle of the case.

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### Denmark.

Denmark. From Copenhagen there is one exhibitor of an elaborately-carved set of spillekens. These are quite models of almost every sort of implement, such as spades, rakes, hammers, picks, billiard cues, scissors, laders, flags, &c.

### Russia.

Russia. The Russian toys are not numerous; but the india-rubber balls and cords for gymnastic exercises are of good and elastic material and well made. They are exhibited by the Russo-American Company for the manufacture of india-rubber at St. Petersburg.

### Egypt.

Egypt. The Egyptian toys are rather remarkable, though rude and original. A large collection was sent; but many, being somewhat cumbrous and not deemed worthy of careful packing, were broken on the road, and so are not exhibited. This is to be regretted, for the remnants show that an entire collection from this country would have been interesting. Included in this class are swinging bassinets, cradles, and small go-carts for teaching children to walk. All of them are of a somewhat curious make.

### Tunis.

Tunis. The only object from this country is a playing die found in the excavation of Carthage, and exhibited by his Excellency Prince Mohamed. It is of stone, rather large, being somewhat more than half an inch cube, and is in a perfect state of preservation; the edges are rounded, but all the sides have the numbers distinctly remaining on them.

### Morocco.

Morocco. The trumpets and tops from this country resemble very much those sold at our small shops and fairs; they are painted in brilliant red and green colours alternately in rings. Some are pegtops, having iron pegs, while others are more like teetotums, to be spun with the fingers.

### Japan.

Japan. A curious and interesting case is sent by the Japanese Government containing toys of all kinds, rattles, dolls with moveable eyes, others of white earthenware with comic faces, cups and balls, little boxes of kitchen articles, &c. Owing to their being sold, it is impossible to induce the custodian to give any information concerning them.

## United States of America.

United States.

This country has but one exhibitor, and he has sent a few geometric puzzles. These are good, and of considerable merit, as they make an immense variety of figures and give scope to the imagination and ingenuity of the child. It is to be regretted that a fair representation of the toy manufacture in America has not been sent to the Exhibition. Many clever playthings are made on the other side of the Atlantic—as, for example, the "walking doll" referred to in connexion with M. Jumeau's exhibits.

## England.

England, Mr. Cremer's stall.

The only exhibitor of toys in the English space is Mr. Cremer, who displays a fine collection of English manufactured goods in this class; the most striking portion of the stall is the dolls, dolls' houses, and dolls' wardrobes. England excels in the manufacture of the best class of dolls, and more particularly those in wax; they are all children in face and dress, and are superior as toys to the make of any other country. Those exhibited by Mr. Cremer are most pleasing, and the modelling of the faces, hands, and feet, shows that no pains or expense is spared in producing the best moulds. The clothes exhibited are quite perfect, everything being made to be put on and taken off. The sleeping apartment of Mr. and Mrs. Doll is a capital example of an English doll's house of the most luxurious kind, though as a toy it is inferior to the model kitchen below; this has a kitchen-range and sink supplied with water and every requisite utensil, even including a working filter. The doll's wardrobes are to a certain extent a novelty, or, at any rate, the perfection in which they are exhibited in this stall. The rag dolls at a slight distance can hardly be distinguished from wax, so well are their faces coloured. The models of ships and boats are popular English toys, as might be expected in a maritime nation, and some of those exhibited are well worthy of note, more particularly a model of the Henrietta, the yacht which won the ocean race last year.

English games.

*Games.*—The exhibitors of games in the English division are not numerous. Cricket is represented by Messrs. John Lillywhite and E. J. Page, both of whom have sent excellent specimens of the requisites for this game. The racket bats, balls, and shoes of Messrs. Jefferies and Malings are made with great perfection, as also those exhibited by Messrs. Cremer, Page, and Lillywhite. It is remarkable that this game should be represented by more English exhibitors than the national sport of cricket. A pair of porphyry curling stones from Edinburgh will be found

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among the English games, they are exhibited by the Lord Provost, and are beautiful specimens.

Mr. Cremer's games are numerous, croquet being the most important. His miniature billiard-tables are well finished, and it may be remarked that this game has come into fashion in consequence of a table exhibited by this maker in the Exhibition of 1862.

A new game, styled "A Summer Excursion," though not well arranged, seems to have its merits, it was invented by the Rev. C. Mackenzie, of the Polytechnic.

## British Colonies.—Canada.

Colonies.

Mr. Peacock, of Montreal, exhibits a set of cricket stumps, bails, and five bats, which are well and strongly made, though somewhat clumsy. There would appear to be a considerable demand for these things in Canada.

## Report on Apparatus and Methods used in the Instruction of Children.—(Class 89.)—By the Rev. Canon Norris, M.A.



Paris, May 1867.

The educational department of the Exhibition is divided into two portions—Class 89 contains all that concerns the instruction of children; Class 90, what concerns that of older persons. The report which follows relates exclusively to Class 89.

France, Prussia, Saxony, Sweden, Denmark, Austria, Spain, and Italy are the nations of the Continent which have contributed most largely to this portion of the Exhibition.

Taking these nations in the above order, I shall briefly notice such of their contributions as have seemed to me most deserving of our attention.

### I. France.

France.

Beyond all doubt the most striking and the most instructive sample of French primary instruction is to be found in the large building in the park (near the Grande Porte) dedicated to the iron-works of Creusot. Here Messrs. Schneider and Company exhibit a most complete account of their magnificent schools. The statistics, methods, rules, time-tables, and works done by the scholars are ranged along the west wall. The schools are maintained chiefly, but not exclusively, for their workpeople's children. These pay 7*d.* per month; strangers, 14*d.* There are 2,219 boys and 1,846 girls in attendance. The boys are taught by twelve masters, the chaplain attending to give religious instruction: the girls, by the Sisters of St. Joseph de Cluny.

Schneider & Co.'s schools at Creusot.

Each of the two principal schools numbers about 900, and is divided into nine classes. The mean age of the highest class of boys is fourteen; of girls, thirteen; the mean age of the lowest class of boys, is eight; of girls and infants, four. The course of instruction is fourfold:—

1. *French*, occupying ten or twelve hours in the week. Under this head come reading and committing to memory; and for the older children grammar and composition.

2. *History and Geography*, occupying about three hours per week of the girls' time, and from eight to four hours of the boys', the younger boys giving more time to it than the elder. A course of Bible history is included in this department.

Rev. Canon Norris on Means for instructing Children.

3. *Science,* occupying five hours of the girls' week, and from six to ten of the boys'; in the girls' school "Science" means arithmetic and bookkeeping; in the boys' school it means arithmetic and geometry throughout, and for the elder boys it includes one hour of natural philosophy and mechanics, one of chemistry, and two of algebra.

4. *Arts,* occupying twelve hours per week in each school. For the girls an hour every day of needlework and another of writing, with two hours of music; for the boys, writing, drawing, and music. On Thursdays and Sundays the children have holidays, with home tasks, which are corrected the next morning.

Good marks are given for conduct and for lessons. These are carefully registered in the teacher's journal, together with his private observations. In August every year the marks of the year are counted up and added to the results of a general examination; the result determines the prizes. To these the boys look forward with much interest; but a far greater incentive to industry and good conduct is the admirable system of *patronage.* To the most deserving boys who leave the school an honourable career is opened in the company's employment as clerks or as engineers, to the next most deserving employment as workmen, while the undeserving have to seek their living elsewhere. This patronage is exercised rigorously according to merit: the poorest boy in the school knows that he may rise to situations of the highest responsibility in the company's service. To this the company ascribe the very remarkable success which has attended the schools. Punishments are seldom needed. Where loss of marks fails to suffice, a letter is written to the parent, and the child's attendance at the school is suspended for a while. In 26 years not more than three cases occurred in which final expulsion was found necessary.

In 1863 a night school for adult workmen was instituted, with an attendance of 100; last year the attendance had risen to 260, and they had asked to have special lessons in machine-drawing. The result of the children's work, drawings, needlework, and copy-books seemed to me admirable.

Plans of school buildings.

From the Creusot school I pass into the main building. There, near the Rue des Pays Bas, is to be found the rest of the French educational exhibition. On the wall will be seen very complete plans of school buildings by M. Uchard, an architect (under No. 8 of the catalogue).

Ventilation.

The question of ventilation is yet unsolved in France as in England. Ventilators in the roof are condemned, and ventilating flues running alongside of the smoke-flues preferred. But the success of this system depends on the length of the flue; and here the

French schools, two or three stories in height, have a great advantage over our single-story schools. Where the rooms are one over the other several stoves combine in winter to increase the upcast draught, and the air-flue sucks the vitiated air through the floor-grates very powerfully; while the warm air chamber of the stove is continually sending a fresh supply into the room. In summer, when the stoves are not lit, valves into the air-flues may be opened in the walls near the ceiling. A specimen of one of these ventilating-stoves may be seen under No. 105. But an open grate (such as those made by Hyde, of Winchester, with hot-air chambers behind them) would fulfil the requirements of this system of ventilation quite as well.

Copybooks.

Passing to what concerns instruction, Taupier's method of teaching writing (No. 51) well deserves attention. His copybooks are published by the great school publisher, Hachette (Boulevard St. Germain, 77). As in the best copybooks of all nations, the child traces a few lines over pale letters before he trusts himself to write unaided, pale lines guide the slope of the letters, and their spaces also, throughout the earlier books. The more advanced copybooks embrace invoices, addresses of letters, elements of grammar, &c.

Arithmetic.

In arithmetic, admirable facilities for teaching decimal weights and measures, the relation of the whole to its metric base being made obvious at once to the child's eye, may be seen in M. Demkes' staircase (No. 76), and in M. Carpentier's cabinet (No. 79). This last is most complete, having a pair of scales in which the several equivalents can be made manifest to the child's eye, each being also brought into relation with the base-metre.

Geography.

In geography, Gervais's altas of outline maps, to be filled up and coloured by the pupil (No. 22), should be especially noticed. The maps are most beautifully engraved, with the mountains in admirable relief, and cost only a penny a piece. (M. Gervaise, Rue du Rendez-vous, 53, Paris.)

Needlework

Among the results of scholars' work but little needlework appears.* The results of the boys' work are very satisfactory.

Drawings.

The portfolio of drawings, especially the machine drawings, from M. Barbier's school in the Rue Neuve-Coquenard, Paris (No. 197), as well as some excellent drawings and maps from the Algerian schools of Oran, well repay attention. But if an Englishman wishes to see the mag-

* Last month a law was passed requiring all communes of more than 500 inhabitants to have a separate *girls' school* under a mistress, and all smaller communes to provide a sempstress for their mixed schools.

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nificent effort which France has made in the last three years to connect together the school and the workshop, he should pass on to Class 90, and there examine the results of the "enseignement secondaire spécial," to which the law of June 1, 1865, is giving such a completely efficient organisation. The professional and technical schools take up the children at the point where the primary school leaves them. Here the girls learn bookkeeping,* wood engraving, porcelain painting, millinery; the boys machine drawing, physics, and generally the principles applicable to whatever trade they are about to engage in. It is clear that the necessity of this kind of education for artizans is better appreciated in France than in England. These schools do not, it is true, belong to Class 89; but this higher course of instruction is beginning to react downwards, on the primary schools, requiring of them a more scientific teaching of the A B C of design. Some results of this may be seen from M. Delahaye's primary school in the Boulevard des Batignolles, 24 (No. 201).

Technical instruction.

Evening schools.

The rapid extension of *evening schools* all over France in the last two years has been most remarkable. In April, 1866, M. Duruy was able to report 22,980 evening schools for men and 1,706 for women, attended by 552,939 men and 42,567 women. These are mainly supported by voluntary effort—three-fifths of the schools being gratuitous. The law of last month offers a premium to any teacher of a day school thus volunteering to open an evening school.

Prussia.

## II. Prussia.

Maps, books, &c.

In a white house in the park a room has been furnished by the Prussian Government with all that a school needs. It might, perhaps, have been better done in some respects; but the admirable wall maps of Kiepert, published by Reimer of Berlin, cannot fail to arrest attention. There is an excellent school atlas by Diehl, of Darmstadt, price 1*s.* 2*d.*; and another by Haester, still cheaper. The reading-books, carefully prepared in a graduated series by the teachers of the Münsterberg normal school, are marvellously cheap. So also are the very complete sets of arithmetic books by Böhme, used all over Prussia. Böhme also exhibits some curious tin slides, to be used in infant schools instead of the ball frame.

A school at Ahrensberg sends a quantity of needlework, done by the scholars, of the highest excellence, and giving evidence of very sensible teaching—no fancy work, all of the plainest utility.

* The bookkeeping of the French tradesmen is almost entirely intrusted to women.

Diagrams for teaching the working of pumps, &c., and of the electric telegraph, may be seen on the walls.

## III. Saxony.

Saxony.

In a little temple in the park is a modest but very excellent exhibition of school books and apparatus sent by Saxony, the cradle of German education; for here in the 16th century were sown the seeds of that system of popular instruction which has since spread over Germany. In the centre is a model of the Gymnastic School of Dresden. On the counters and walls are to be found Lange's excellent altas (Leipsic), giving a full account, physical and commercial, of Saxony; Delitsch's elementary Atlas of the World, a marvel of cheapness (six maps for 14*d.*); Lüben's Atlas of Botany, which they seem to teach carefully in the Saxon schools; Schnorr's Bible woodcuts; and much else worthy of attention.

Books and apparatus.

## IV. Sweden.

Sweden.

The Swedish Government has furnished the lower chamber of a most picturesque little wooden house so as to represent one of their small village schools. Since 1842 education has been obligatory in Sweden; the entire absence of dissent makes it possible for the Government to work the schools through the ecclesiastical organization of the country. Each parish is rated according to its requirements, as reported by the clergyman and approved by the inspector. If we may judge by what is here seen, the furniture is of an almost sumptuous kind. Each child has a small desk and seat to himself; the desk holds his books, &c.; the seat has a back. The teacher thus passes freely among all the children. In the larger schools of more thickly-peopled countries this would be of course impossible.

Obligatory education.

School furniture, &c.

The maps of Scandinavia are perhaps the most striking school maps in the whole Exhibition. They are by Mentzer of Stockholm (No. 11). The stove is of earthenware, as in their houses, warming the air by conduction, not by radiation.

## V. Denmark.

Denmark.

From Denmark I find a very complete collection of scholars' work from the various primary schools of Copenhagen. The boys' drawings and writing books are good, the girls' needlework admirable. In all the schools the English character of writing is taught as well as the German.

An excellent adult night school, supported by voluntary subscriptions, for teaching drawing, also sends good results.

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In England a school for teaching drawing would hardly draw forth the charitable contributions of our gentlefolk.

## VI. Austria.

Austria.

The well-stored assortment of school apparatus sent by the Austrian Government is nearly all under glass, and difficult to examine.

Globes, &c.

The best globes of every size and price are from Austria. Steinhauser's maps of physical geography, Frobel's "Kindergarten," Patek's apparatus for teaching arithmetic, from the St. Anna School at Vienna, all deserve notice. I never saw in an English school the Vienna frame for teaching vulgar fractions. It is like a ball-frame, only on the wires, instead of balls, you have divisible reeds. The uppermost is undivided, and represents the integer. From those below, which are divided into fractional parts, and run on the wires, the child sees at once (for example) that three-fourths are equal to six-eighths, greater than two-thirds, less than four fifths, &c.

Drawings.

In large portfolios are to be found specimens of drawings in every stage. Better methods of teaching drawing in connexion with ornamentation can hardly be conceived. In this respect the Austrian exhibition seems to me unrivalled.

Telluriums and planetariums.

I may also mention very cheap telluriums and planetariums, from 30*s.* to 5*l.*, sold by Felkl, of Prague. By lighting the lamp and turning the handle, the whole theory of day and night, of the seasons, and of eclipses, is shown to the child at once. One of the cheaper sort might well be in every village school. All the Austrian school apparatus seems to be far cheaper than that of France or England.

Spain.

## VII. Spain.

In the upper room of an elaborately carved and turreted house in the park is to be found the Spanish school exhibition. Without an interpreter it is difficult to understand it.

School-desk.

The eye is at once caught by a school-desk, long enough for five children, supported by five simple cast-iron standards. Instead of a bench, as in England, with all the attendant inconvenience of stepping over, there are five round seats, each seat resting on a continuation of the iron standard, like so many music-stools before a pianoforte. When the class is told to stand, each child stands at once *by the side of* his seat, and can leave or resume his place without difficulty. When used for needleworks, cushions are attached to the desk, to which the girls may pin their work. Under No. 87 will be found a cheap box of geometrical solids of walnut-wood, the best, perhaps, in the Exhibition.

Morenilla's method of teaching reading (No. 73), and Iturzaeta's writing copies (No. 91) appear to be good. Avendaño (No. 88) is their great publisher of school books at Madrid, and Bastinos, of Barcelona (No. 33), is a well-known house for all sorts of school apparatus. There is a society (or junta) of noble ladies at Madrid who maintain a normal school, and have founded numerous elementary schools, also represented, though inadequately, in this exhibition.

## VIII. Italy.

Italy.

The exhibition from Italy indicates a rapid and satisfactory progress in the last few years. The Minister of Instruction and Worship sends a very complete assortment, including a full account of their recent legislation in favour of education. Paravia, the great publisher at Turin, sends text-books of every sort; those of Lambruschini and of Carbonati are reported to be excellent. Perrin, of Turin (No 13), sends copy-books as good as any in the Exhibition, to be had for half the cost of English copy-books. Luca, of Naples (No. 38), sends very good books on geography. All their older educational societies have been recently consolidated into the Italian Association for the Education of the People, which (under No. 21) exhibits good evidence of progress. The architectural and ornamental drawings from the schools of Naples, Venice, and Padua are most beautiful.

It is to be regretted that some other countries in which education has already made, and is now making, great progress, are so inadequately represented.

Belgium sends but little:—The school-books of Braun (No. 2) and of Willequet (No. 16), Joly's Atlas (No. 11), and Callewaert's (No. 3) should be noticed. Belgium, &c.

Holland and Switzerland, both nations honourably distinguished for what they have accomplished in the cause of popular education, send nothing. Canada.

Canada sends excellent school-books (note especially the commercial copy-books) from the upper province and school apparatus from the lower. There is also an interesting model of the village of St. Anne, showing the great agricultural school and its system of husbandry. The model was made by the teachers of the institution. St. Anne.

United States of America.—Nothing belonging to this class had arrived at the date of this report (May 14).

Such are my principal gleanings from my month's study of this portion of the Exhibition. But, in conclusion, I must record my strong impression that any educational exhibition Conclusion.

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of this kind must be, from the nature of the case, unsatisfactory; as a test of comparative progress it is clearly untrustworthy. Nations whose administration is highly centralised are sure to appear to advantage as compared with those which trust chiefly to voluntary effort; and of the work done it is the *material, i.e.*, the least important, results only that can be properly represented. How, for instance, can a teacher's success as a disciplinarian be made to appear in such an exhibition? Even of the mechanical appliances a trustworthy judgment can hardly be formed unless one has a practical teacher by one's side to answer the question, "How do they work?" And of the real tools of a teacher, his school-books, it is of course impossible to make any profitable examination while standing before a glass case. Still Class 89 contains abundantly enough to interest an English schoolmaster, and the above report may perhaps help to direct him to what will best repay his attention.

## Report on Apparatus and Methods used in the Instruction of the Blind.—(Class 89.)—By Edmund C. Johnson, Esq.



Class 89 contains many interesting appliances and methods for the instruction of the blind, exhibited by the undermentioned countries:—France, Austria, Italy, Prussia, Holland, Belgium, Denmark, Würtemberg, Spain, Sweden, Italy, America, and England.

It is proposed in this report to give a short summary of the principal objects of interest in each country, under the following heads:—I. Books or treatises on the education of the blind. II. Apparatus used in the instruction of the blind. III. Results of manual labour in the workshops and schools.

Austria and France occupy the first positions in this section of education.

### Austria.

Das K. K. Blinden-Erziehung's Institut, in Vienna, is a school established by the State, having a central government and schools in union throughout many parts of the empire. It contains about 200 pupils, under the direction of M. Pablasek, a very learned and philanthropic professor. The male and female pupils are lodged, fed, clothed, and instructed in reading, writing, arithmetic, geography, music, basket-making, matmaking, turning, ropemaking, blind-making, and needlework. The musical instruction includes vocal and instrumental music and composition. An asylum and workshops for the employment of the pupils of this school above age have also been established at Vienna, and found to be of the greatest utility. Mr. Mathias Sohlentung tells us in his report:—"At present there are 75 workers "—43 males and 32 females. The most productive of the "trades are basket-making, bookbinding, and knitting. The "expense of keep per head is about 21*l.* The profits of the "musicians," says the report, "who play in cafés and "restaurants, are very considerable. They induce many of "our best pupils to leave as soon as they become useful to "the charity."

Austria State School.

There are two itinerant groups of blind harmonists in Vienna who subsist in this manner; one a mixed band of instrumentalists and the other a society of harpists, who have

Itinerant blind musicians.

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been instructed by Mr. Zakreiss, the professor of that instrument at the Royal Institution for the Blind.

Manual labour.

Attention to intellectual education, rather than to gain a good livelihood by manual tradal employment, has hitherto been the principle of action in the treatment of the blind at Vienna. It is, however, a subject of congratulation that the Germans are gradually working round to the English and American systems of teaching the blind useful manual labour, with moderate primary intellectual instruction. Dépôts for the sale of work are opened in Vienna, in connection with the Home; and also an Infant School.

Treatises exhibited.

I. Three treatises are exhibited:

*a.* "The Blind from the Cradle to the Grave," by M Pablasek, Director des genannten Institutes, Wien, 1867. A work of considerable merit, including the latest results of his own experience, with full directions as to the primary and secondary education of the blind.

*b.* "Reports of the Blind Institution of Vienna."

*c.* "Sketch of the Life of J. W. Klein" (late director of the Imperial School for the Blind): an interesting memoir of one of the great German philanthropists, the originator of blind schools in Germany—he and Valentine Haüy, of France, being the pioneers in this branch of primary instruction.

Apparatus.

II. Apparatus for instruction:

Alphabet.

*a.* Zum Lesen mit lateinischen Alphabet, von M. Pablasek. A frame and letters for teaching the alphabet.

This is a very useful little box, about one foot in length, and a foot in width; the lower part being divided into small partitions, like a compositor's desk, each containing a letter stamped in relief. The metal of which the letter is composed is light and firm, half an inch in length and two-thirds in breadth. The characters employed are the common Roman type (lower-case letter), together with numerals and stops. The inferior edge of each letter-plate is stamped with a small dot, which indicates the position in which it is to be held, the dot downwards. The upper compartment of the box is furnished with a series of slides, into which letters can be inserted when words are spelt; and a small slip of wood, with two screws, holds the letters together when the page is completed. A blind child, by this simple apparatus, can be taught the exact form of each letter, *in relief;* can practise the combination of letters in the formation of words, and exert any amount of pressure with the finger upon the type, without destroying or detracting from its sharpness.

The frame forms a sliding drawer or cover to the box, and can be obtained at the Imperial Blind Institution, at Vienna, price 1*l.* 18*s.*

Embossing machines.

*b.* Stacheltypen von J. W. Klein, a machine for embossing, with type made of pins' points. This is the apparatus used in the blind schools of England and other countries, where the ordinary Roman letter is employed. It consists of a box of type, with metal lines, between which the type can be worked. The letters are too fine, as to points, for the use of ordinary blind children, and the machine is too costly (12*s.* 6*d.*) to be used with advantage by the poor.*

*c.* Braille Punktypen von M. Pablasek, a small embossing press on Braille's system. This is a compact little box, containing the necessary type for a correspondence between blind persons. Its portability is a great recommendation, as it contains a reserve of type (made in France), an embossing desk which folds into a small compass, and a "guidemain" to receive the type. It is highly to be recommended as a portable desk: and other type than that of M. Braille can be substituted when required. Price 1*l.* 8*s.*, complete.

*d.* Zur Markirung der Spielkarten fur Blinde von J. W. Klein (for marking playing cards) is a little instrument of but small value in an educational point of view.

Result of manual labour.

III. The results of the manual labour of the pupils are not very remarkable. The basket-making department exhibits four different specimens of round, flat, and split skeinwork. The price is too high to command a market, whilst the colours introduced are by the hand of the masters. The window-blinds, manufactured with small spills of wood joined together by string, are novel features in this Exhibition. They are cheap and well made, and merit especial notice. It is in its turnery that the Imperial School at Vienna excels. The specimens consist of boxes, egg cups, needle-cases, and various objects turned by the blind, which for beauty and cheapness cannot be surpassed.

Switzerland, France, Austria, and Prussia are the chief countries in which turnery is made an occupation for the blind.

Various specimens of female work may also be noticed, such as knitting, netting, shoe and slipper making; though inferior to the productions of other countries.

Private schools.

There are three private schools in the empire of Austria, which exhibit in class 89—viz., 1, Linz; 2, Pesth; 3, Brünn (Moravia).

1. The school of Linz is an institution supported by private subscription, with a small rate in aid from the Government.

* N.B.—The ordinary writing-desk of England, as in operation at the School for the Indigent Blind, Southwark, is more perfect in its construction, and is less costly.

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Books in raised letters are exhibited, in the ordinary lower-case type, well embossed, and moderately cheap. Portions of the Bible form the only literature in use at this school.

The industrial products are few; straw mats, cane-work, string, knitting, and sewing are the only specimens exhibited.

2. The school of Pesth is the single establishment in Hungary for the instruction of the blind; and, like that at Vienna, is under the direction of the Government. A few embossed books, in the Roman character (Magyar reprints from similar works in German), and some well-made string and stockings, indicate considerable progress in primary instruction amongst the Hungarian blind.

3. The school of Brünn (Moravia) is, perhaps, the most remarkable of the private blind schools of Austria. It is supported by voluntary subscription, receives a small subsidy from the municipality of Brünn, and is especially devoted to "instruction in manual labour;" it resembles an institution for promoting the general welfare of the blind founded in London by the well-known Miss Gilbert.

Shoemaking.

The specimens of shoemaking are wonderful—indeed so startling, that if they be really the work of the blind, they are deserving of especial notice. Hemming, marking, sewing, and plain needlework are brought to the highest point of perfection in this establishment.

## France.

France. History of the Institution Impériale des Aveugles de Paris.

L'Institution Impériale des Jeunes Aveugles de Paris.—As long ago as 1784 ten or twelve poor blind musicians were executing a discordant symphony in one of the streets of Paris. Crowds of people were attracted by this novel exhibition, but more particularly a simple passer-by of the

Valentine Haüy.

name of Valentine Haüy. The philanthropic mind of this great man at once conceived the design of regularly educating the blind. About the same time a young German lady, Mdlle. Paradis, who had been blind from the age of two years, arrived in Paris, accompanied by a blind instructor, of the name of Vesinburg. Haüy fortunately made the acquaintance of Mdlle. Paradis, whom he found both intelligent and useful in drawing up "Un Plan "Général d'Institution pour les Enfants Aveugles." Chance also threw in his way a young man named François Le Seur, who, blind from his birth, had up to the age of sixteen subsisted by begging at a church door. At the period when Haüy found Le Seur, the latter had begun a course of self-education—half his day being devoted to intellectual exer-

cises, and the other half to begging in the streets. Valentine Haüy, struck with these two remarkable instances of energy, drew up a memoir, which was read before the Société Philanthropique, of which Lenoir, the celebrated lieutenant of police, was president. The society at once sought out twelve blind children, and placed them under the care of Haüy. A little house was taken in the Rue Coquillière, and the Academy of Sciences was called upon to determine on the best mode of instruction; whilst Valentine Haüy invented characters in relief, taught the blind to read, and set to work to print books in raised letters for their instruction in music and geography. The report of the Academy does not make any mention of *manual labour*, though it is believed that the blind children, even at this early period, made tape and small baskets.

In a short time the Royal Academy of Music gave a concert at the Palace of the Tuileries in behalf of the institution; and in December 1786 the blind children were admitted to the Palace of Versailles, and "displayed their "proficiency" before the King and Queen, "who lodged "and entertained them in the château for more than eight "days." Immediately after this Haüy published an essay, "Sur l'Education des Aveugles," a book which was printed partly *in relief* by his pupils. In 1787 his school numbered thirty pupils, some of whom paid a small monthly subscription, the rest being totally indigent. Various manual works, such as knitting, netting, string and rope making, were taught with various success; the instruction in music taking the first rank, under the constant care of the celebrated composer, Gossec. In 1787 the musicians of the school of Haüy took part in a grand religious service at the Church of St. Eustache, many of the pupils making their first communion, and chanting a mass which had been written for them by Gossec. In 1788 the pupils of Haüy augmented to the number of fifty; and on the Feast of St. Valentine a temporary chapel was erected in the establishment, where a full choral service was performed by the pupils, in which the blessing of the Almighty was invoked, and their voices raised in prayer, "Pour le vrai bonheur de l'institution, et "pour son père adoptif." Amongst the pupils was young Gailliod, who had been admitted into the school at the age of nine years. His great aptitude for music soon enabled him to become an expert organist as well as a skilful player on the violin. In 1789 Haüy determined to admit *seeing children* to some of the advantages of the institution; and, on small payments, upwards of a hundred were (strangely

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enough) instructed in music and in the primary branches of education *by the blind.* These classes only lasted until 1791. All was going well with this blind school until the Revolution, which threatened to overthrow all the charitable institutions of France. "The blind, imitating their seeing "confrères, cried aloud for liberty and independence;" and a little emeute took place in the establishment, which, after some difficulty, was suppressed by Haüy. But a greater danger menaced it. The Philanthropic Society became daily weakened by the dispersion of its members, and it ceased to contribute funds for the support of the blind school. These were hard times for Haüy, who, failing in his applications for relief from wealthy demagogues, turned with a heavy heart to the Government. Assistance was for a long time refused. At length, "by a decree dated July 1791, the National Assembly assigned the house and funds of the Convent of the Celestines to the wants and necessities of the deaf and dumb and the born blind. Thirty blind and thirty deaf and dumb children were boarded and lodged in the institution. This singular arrangement of mixing the two classes of unfortunates introduced a novel and undesirable feature in the institution; and no less than nineteen masters and mistresses were appointed to supervise thirty blind children. The establishment was next transferred to the religious house of St. Catharine, in the Rue de Lombard, where it fell into the greatest confusion; and it was not until 1795 that the National Convention once more gave an impetus to the undertaking. The school changed its name to that of "Aveugles Travailleurs," every pupil being instructed in a trade, and, after a residence of five years, leaving the establishment with a gift of 300 f. The poor blind gained but little by this apparent liberality, as their portions were paid in worthless assignats.

When the first years of the Directory gave hopes of returning order and confidence in France, the blind school participated in the temporary amelioration of affairs. The Hospital of the Quinze-Vingts and the Aveugles Travailleurs were united, and in 1801 the trade workers were transferred to the former institution. Haüy, thoroughly disgusted, resigned his place, and the affairs of the blind fell from bad to worse. The manufacture of cloth, which for a long time had been declining, was discontinued in 1803, and but two hours a day were devoted to instruction, of a very imperfect character. In 1805 the Government once more turned an anxious eye upon the institution, reviewed the work that Haüy had so well begun, and in 1814 appointed Dr. Guillie head of the

Dr. Guillie.

establishment. By his able advocacy the institution was separated from the Quinze-Vingts, and M. Dufau was nominated as second instructor. To the great talent of M. Dufau, who was called to fulfil these important duties at the early age of twenty, the institution is indebted for its present prosperity; and it is not too much to affirm that to his fostering care, his large and comprehensive intellect, his deep research, both in the moral and intellectual capacities of the blind, that such good results have been achieved. In 1816 the institution was transferred to the ancient College of Les Bons Enfants, in the Rue St. Victoire; and in 1817 Guillie placed the school in certain train for success. Thus in 1819 and 1820, many books were embossed in the asylum: among others an English Grammar, two volumes of English extracts, a Latin grammar, an Italian grammar, two volumes of extracts from Italian authors, a Greek grammar in two volumes, a volume of extracts from Greek authors, a Spanish grammar, two volumes of geography, and many books on religious subjects. In 1820 the embossing-press of the school produced other works, including the Catechism, choice extracts from Latin authors, and two volumes of Horace and Virgil. It is somewhat remarkable, however, that the press of the institution did not produce any treatise on arithmetic or history; and that pupils only learned music and composition by methods used at the Conservatoire. The orchestra, even at this time, was worthy of public attention. The manual employments, both of the male and female pupils, included the manufacture of purses, knitting, slippers and shoes, in "peluches de laine," brooms and whips. The boys worked at the loom stuffed chairs, turned; and manufactured straw mats. Dr. Guillie was very anxious to establish an asylum in the country, where the pupils who left the institution could work in little gardens, follow a particular trade, and become members of a self-supporting community; but this excellent plan was never carried out. Dr. Guillie retired in 1821, and was succeeded by Dr. Pignier, who received the title of Director. M. Dufau, however still remained in the establishment as professor, and continued to give his lectures in grammar, rhetoric, and philosophy. The little orchestra received fresh encouragement from Habeneck, Da Costa, Dauprat, and Guillou, who gave their gratuitous services as professors, and in 1832 a blind pupil became organist at one of the principal churches. The years 1825 to 1829 were of great importance to the institution, in consequence of the introduction of a new system of writing and printing—the system of embossed points.

M. Dufau.

Point-writing and printing.

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M. Barbier's system of teaching writing.

M. Charles Barbier was the first person who entertained the idea that the blind might be taught to write, and yet read their own composition "sans connaître la figure des lettres, "l'usage de la plume ou du crayon, les règles de l'orthographe, "ni les difficultés de l'épellation."

The Abbé Carton, in his admirable work on "Les Etab-"lissements pour les Aveugles en Angleterre," gives the following tabulated plan of Barbier's system:—

| | | | | | | | | | | | | |
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"Il ne fallait pour tout instrument qu'une règle rayée dans son milieu, de six lignes parallèles et creusées dans le bois sur laquelle ou posait le papier qu'on retenait par une espèce d'agrafe, ou sur laquelle on mettait une réglette platte en cuivre percé de carrés."

Louis Braille.

This novel method was further developed by a young man of the name of Louis Braille, who after much labour and thought perfected a system of point-writing, which has since been widely adopted in France, Switzerland, and Spain, and is daily making immense strides in the schools of other countries.

ÉCRITURE À L'USAGE DES AVEUGLES, PROCÉDÉ DE MONS. L. BRAILLE, PROFESSEUR À L'INSTITUTE DES JEUNES AVEUGLES, À PARIS.

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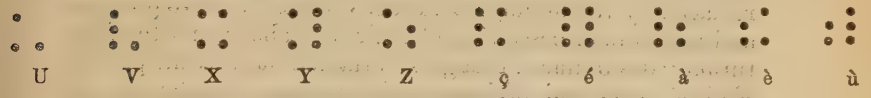

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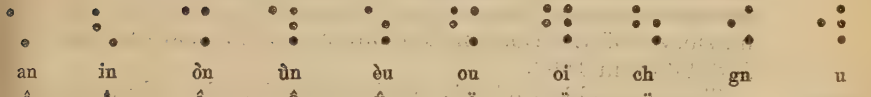

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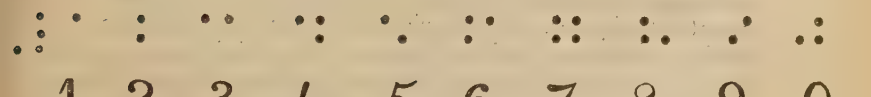

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Mr. E. C. Johnson on Means for Instruction of the Blind.

Claude Montal.

Pianoforte tuning.

M. Dufau lost none of his energy and perseverance as years rolled on; for we find that in 1830 he took by the hand Claude Montal, a pupil of the school, and advanced him to the position he now occupies. Montal obtained permission to be instructed in the tuning of pianofortes, and ended by becoming a renowned maker of that instrument. His example led M. Dufau to train others in the same branch of trade. At the present time many blind pianoforte-tuners have created for themselves a lucrative "métier" in Paris and other parts of France.

In 1839 a new site was appropriated by the Government for the purposes of the charity, and the first stone of the present school was laid with much éclat. The whole establishment was reorganised, and M. Dufau, after twenty-five years of professorship, was raised to the position of director; M. J. Guadet, the present active chef de l'enseignement being created "instituteur," and the old mistress of the house replaced by the intelligent Mdlle. Cailhe. In 1843 professors and pupils took possession of their new abode, and the Institution "des Jeunes Aveugles" attained its present position. Full of years and of honour, the veteran director, M. Dufau, retired into private life at the beginning of the year 1855, and he has since enjoyed the affection and respect of all who know him. He still lives at Versailles, takes a deep interest in the welfare of the blind, and assisted the Commissioners of the London Exhibition in 1861, and the Paris Exhibition in 1867.

Object of the Paris Blind School.

The chief object of this excellent charity, the only one in France subsidised by the Government, is to rear blind children of both sexes—to give them an education according to their several capacities—and to instruct them in a trade or liberal profession. It may fairly be considered as the parent blind school of France, as all the other institutions of the country adopt it is a model, and are regulated by its rules and practices. The studies are divided into three divisions:—I. Intellectual. II. Musical. III. Industrial.

Studies.

I. The intellectual instruction is of two kinds —primary and secondary.

Primary instruction.

The primary consists of reading, grammar, arithmetic, sacred history, natural history, and the elements of geography. The secondary includes the higher portions of grammar, composition, arithmetic, geometry, and the rudiments of physics. Every class is under the direction of a seeing professor; whilst those of the children who show peculiar talent are taken to lectures at the college of France or the Sorbonne. A good classical library has been formed

in the institution (embossed in relief by the blind pupils), which is often increased by the addition of the newest literary and standard works.



II. Musical instruction is the great feature of the establishment. Ten blind professors are permanently retained in the school, who give their entire time and attention to the pupils, and form the nucleus of the orchestra. Instruction is given both on the pianoforte and organ; and many of the advanced pupils gain lucrative appointments as organists at the different churches in Paris and the provinces. Vocalisation and the theory of musical composition are also taught to the elder pupils with considerable success. *The occupation of pianoforte-tuner* arises out of this section, and has been attended with such favourable results in France, that it would be well for other countries to recognise this branch of lucrative employment for the blind.

Musical instruction.

Pianoforte tuning.

Claude Montal, the son of a saddler, was the first blind man in France who turned his attention to this subject. He was born at La Palisse, on June 28, 1800, and became totally blind at the age of five years. Soon after he showed remarkable precocity by tracing letters with a pin upon paper, and in this way teaching himself to write. His love of music was very great, and he soon manufactured a violin on which he played several little airs. Added to this, he learned the flageolet and other instruments, and obtained a fair idea of arithmetic and mathematics. He was admitted into the Paris blind school in 1816, where he made great progress, both in music and in manual labour. Here he became acquainted with Turcas, who helped him in his studies. One day Turcas and Montal, finding the pianoforte of the institution somewhat out of tune, attempted to arrange it; and, though successful, got into disgrace with the director for what was called their meddling propensities. Turcas, nothing daunted, purchased an old instrument, upon which he and Montal practised the art of tuning. The organ of the chapel was next experimented upon, and the director intrusted its reparation to Montal. The two blind men not only executed this work, but adapted a new set of pedals to the old instrument. Montal from that moment determined to create an independent position for himself. He left the institution, took regular lessons in tuning, and subsisted by giving instructions in grammar and arithmetic, the violin and pianoforte, at the low rate of from eight to ten sous a lesson. He was fortunate enough to make the acquaintance of M. Laurent, one of the professors of the Conservatoire, who recommended him, as "le meilleur accordeur de Paris," to

Claude Montal.

Mr. E. C. Johnson on Means for Instruction of the Blind.

Zimmerman and Adam. These eminent composers procured him plenty of work. In 1842 Montal gave some public lectures on the art of tuning, and published his little book entitled "Abrégé de l'Art d'Accorder soi-même son Piano." This had a great success in the artistic world, and subsequently led Montal to commence the manufacture of pianofortes, in which he succeeded beyond his most sanguine expectations. From small beginnings he ultimately became one of the great piano-forte makers of France, and was even appointed fabricant to the Emperor and Empress.

Method of teaching pianoforte tuning.

"It requires three years," says M. Guadet, "to train a blind man to become a good tuner." In the first year a correct notion of the exterior form of the square, the upright, the oblong, and the grand pianoforte is acquired, every part of which he is made to touch and examine. The instrument is then taken to pieces, and its mechanism thoroughly explained, the name of all its parts committed to memory, and their readjustment in the formation of a perfect instrument. After this preliminary work (more necessary for the blind than the seeing) the professor points out the position and order of the pegs in different pianofortes, and the mode in which the strings are applied. At this point the special instruction in tuning begins. The sound which the ear most easily appreciates is that of unison. A note is produced by the tension of one string; a second string, and then a third, is extended, until perfect unison is arrived at. In this way the tones of thirds and fifths are produced, until the ear of the blind man can thoroughly appreciate concord and discord. "The object of this work is to make the hand dexterously "subordinate to the ear." Thus the pupils learn to make octaves, fifths, and thirds. "In that which concerns the "division of the strings into the required number of octaves, "the professor explains how the intervals are adjusted, as "on this depends the entire equality of tone throughout "the perfect instrument." It requires immense application and patience on the part of the pupil to acquire this precision. The division once made, the pupil fills in the strings, octave by octave, regulating by the octave above and below the harmony of the whole. It is obvious that some knowledge of music must be superadded to this mechanical employment.

"In the second year the pupil is allowed to tune the pianofortes of the establishment, under the guidance of a professor. The institution possesses twenty-one pianofortes on the boys' side and eleven on the girls'—thirty-two in all. An hour and a half each day is devoted to tuning, which

accustoms the learners not only to tune well and quickly, but to keep the instruments in perfect condition."

During the third year the pupils are sent to the workshops of large manufacturers—have the advantage of examining every kind of pianoforte—get accustomed to exercise their trade in fresh localities, and gain that confidence which they so much require when going about alone to tune instruments in private houses. "They also live amongst the seeing and "learn to compete with them in their work." There are many reasons why blind men should be good pianoforte tuners. They have more delicate ears than the seeing, and are for the most part musicians; whilst the generality of seeing tuners in France are simple mechanics. In the Paris blind school they receive a theoretical instruction in music at the same time that they are executing their manual calling of tuners.

"En définitive," says M. Guadet, "toutes les fois qu'un art ou un métier sont tels que la cécité n'y est pas un obstacle, que l'aveugle peut les exercer à avantage égal avec les voyants, qu'ils sont de nature à faire disparaître la différence qui existe entre eux, cet art, ce métier, sont favorables à l'aveugle, il faut se hâter de les lui donner. Or, en fait d'accord des pianos, l'aveugle n'a aucune infériorité, il a certains avantages, au contraire, l'expérience le montre chaque jour, il faut donc faire des accordeurs; il n'y a pas à craindre due le travail manque aux accordeurs, il faut donc en faire autant que les circonstances le permettront."

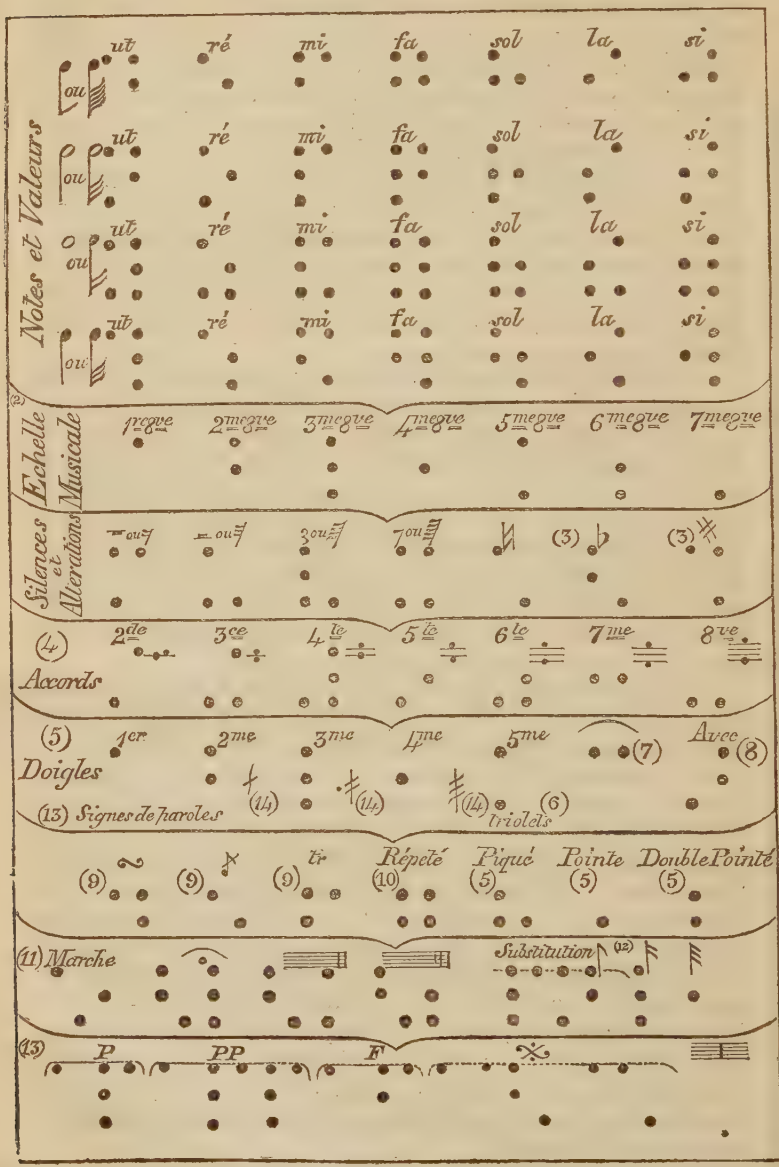
Orchestra of the Paris Blind School.

The orchestra of the Paris blind school demands our special notice. The professors of the institution form the nucleus. "The one who is at the same time chief of "the orchestra is also professor of the first violin; another "of the second violin; a third and fourth, the violoncello "and bass; a fifth, the contrabasso; a sixth, the first "clarinet; a seventh, the first flute; and the eighth, the "trombone." All these professors aid in the instruction and performance of the band, which is not considered complete without them. The band consists usually of three first violins, three second violins, two alto violins, four basses, two contrabassi, two flutes, two clarinets, two hautboys, one bassoon, three horns, one trombone, one ophicleide, timbrels, large drums, triangle: thirty performers in all. The number, however, is frequently augmented to thirty-six performers, many new pupils having lately been admitted as members of the band.

Mode of execution.

The mode in which they execute a piece of music, overture or solo with orchestral accompaniments, is the following:—

SUITE DU PROCÉDÉ L. BRAILLE MUSIQUE.



Their chief writes the notes of the *morceau* to be performed in Braille's system of pointed notation; reads with his finger from the raised music the first bar of the score of the first and second violins, which is taken up by the blind pupil, who produces the bar upon his instrument. Thus the master is enabled to judge whether it has been properly understood. He does the same with the second violin, the altos, and the bass, and for the other instruments. The bar or movement is then played in concert, and the proper time and measure determined upon. The next bar is studied in the same manner, and so on throughout the piece.

At the next rehearsal he continues his instruction, and then puts together the various morceaux that have been learned during the two sittings, superintending the practice and rehearsal of the entire orchestra until it is able, by memory, to perform the "motive" with precision.

"It is with difficulty that seeing players can be brought to understand how the executants remember their different parts, know when to stop, and where again to resume their accompaniment — how each instrument and each part are completely under control, and how they succeed in proper time and proper measure. All is done with a precision and an enthusiasm seldom witnessed in an orchestra of seeing performers, spite of the bâton of its leader or the well-written score of each instrumentalist. It is precisely because the blind need not this assistance, and require neither bâton nor music to read from, that they play with precision and correctness and reproduce their several parts with feeling and spirit."

Difference between blind and seeing musicians.

The difference between blind and seeing musicians is now pretty well understood. The blind are obliged to learn by heart all the music they attempt to play, whilst the seeing often execute at sight. The first, though they may play little, are conversant with every portion of their study and well grounded in its theory; whilst the second read rapidly and execute fluently, but may understand or retain little of what they so hastily acquire.

Industrial work of the school.

III. The industrial work of the pupils is best explained by reference to the objects exhibited at the Exhibition in class 89. They consist of baskets, various specimens of turnery, string-making, chair and cane work, knitting, netting, and the usual trades and employments of the blind. These specimens are very well and neatly executed, though the work of the blind girls takes the lead in excellence and finish. Many objects of turnery are worthy of notice, particularly a pair of candlesticks, a pair of cups (St. Lucie), a pair of ebony candlesticks (Louis XVI.), a pair of antique

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ebony cups, and several wooden cigar cases. The work of the girls includes every variety of tricot, crotchet, and needlework, all excellent of their kind; whilst chessboards, embossed playing cards, and tablets for marking cards complete the catalogue.

Historical nature of the exhibition.

One peculiar feature of this exhibition is its historical nature. M. Guadet, the Chef d'Enseignement, has collected together a most interesting museum of all the appliances and apparatus used in the instruction of the blind since the middle of the last century, arranged in the following order:—

Writing machine

Writing machines.—Haüy's handguide, 1784; Heilman (a blind man) handguide, 1788; Gatteaux, engraved plate for teaching formation of letters, 1794; De Pongus, handguide; Becke (blind man), handguide, 1852; Fournier (blind man), handguide; Challons, process of writing in relief; Guerault (blind), plan for directing the fingers; Duvigneau (blind) handguide; Bruno, handguide, 1854; Dufau, regulating slate; Gall, Edinburgh typhlographe? Hurtlendy (blind), typhlographe; Bird (blind), typhlographe; Masse (blind), typhlographic slate; Balleu (blind), key typograph; Hughes, typograph; Levitte, typograph of Hughes adapted to the use of the French language; Schiott, typograph; Braille, reglette for writing in the ordinary characters; Foucault (blind), instrument for writing in relief in the ordinary characters; Foucault (blind) perfected instrument; Barbier, tabular system of writing, 1821, and other instruments; Braille (blind), three machines for printing in relief, pointed system; Fournier (blind), an instrument for writing on Braille's system; Laas d'Agneu, arithmetical calculating instrument on a modified system of Braille, calculating boards.

Geography, &c.

Geographie.—Weissembourg, aveugle, carte géographique, 1810; Guillié, cartes géographique, 1819; Dufau, carte géographique, 1824; Laas d'Agneu, carte géographique, 1835, cartes géographique gravées, 1847; Levitte, cartes géographique, obtenues sur planches autographique, 1866; Levitte, quatre planches d'images en relief pour servir à l'étude de l'histoire naturelle; David, un cerf et un éléphant plastiques, spécimens d'une collection des principaux types d'animaux réduits au dixième pour servir à l'étude de l'histoire naturelle, 1863; Pignier, figures géométriques, 1833; Levitte, planches autographiques pour l'impression des figures géométriques, 1867; Types de Haüy, Essai sur l'éducation des aveugles 1786 (relief noircé); catechisme de Paris (types abréviateurs); Guillié, notice historique sur l'instruction des jeunes aveugles, 1819; élémens de lecture, 1820; fantaisie pour la clarinette (speci-

men de notation musicale par lettres) 1831 ; Société Biblique, histoire ancienne, 1841 ; Philadelphie, solfège de Gauthier, 1841 ; Dufau, arithmétique de Dufau ; Barbier, specimen d'impression, 1827 ; Braille procédé pour écrire au moyen de points les paroles, la musique et le plain chant, 1829 ; Le même, deuxième édition corrigée, 1837 ; histoire naturelle ; methode de piano par Kalkbrenner ; group photographique de l'orchestre et du chœur de l'institution.

Travaux des Elèves. — Atelier de Filets : Epervier goujonnier de vingt mètres ; tambour à mailles carrées ; verreux ; bourriche.

Atelier d'empaillage et de camage des chaise.—Un Siège en paille ; un Siège en canne.

Atelier des Tourneurs.—Paire de flambeaux néo-grec (bois de rose). Paire de coupes (Sainte Lucie). Paire de flambeaux Louis XVI. (ébéne). Paire de coupes antiques en ébéne, sur piedestaux en bois de rose. Deux porte cigarres fantaisie (ébéne). Ouvrages des filles : tricots divers, filets divers, crochet.

Guadet, L'Institut des Aveugles de Paris, son histoire et des procédés d'enseignement. L'Instituteur des Aveugles (8 vols).

Jeu de dames, jeu d'échec, jeu de cartes, tablette à marquer les cartes—à l'usage des aveugles. Game

Number of pupils at present in the school, 202—135 males, 67 females.

The points worthy of especial notice in connection with the Paris Blind School are three in number :— Noteworthy points in connection with Paris Blind School.

1. Adoption of the system of Braille, both in printed books and as an ordinary mode of writing and embossing.

2. The musical instruction and the instrumental band.

3. The encouragement given to blind pianoforte-tuners and their advancement in the world.

The jury have awarded a gold medal to the Institution des Jeunes Aveugles ; silver medals to Mr. Guadet, Mdlle. Cailhe, and Mr. Siou, a blind pianoforte-tuner ; and a bronze medal to Mr. Levitte for his typograph of Hughes, adapted to the French language.

M. Colart Venoit has separately exhibited his machine (88) for enabling the blind to write music, Mr. Duvignau (89) his "guide main," Mr. Renaux (90) his "guide main" et "porte "plume encrier," and Mr. Sinet his "regulateur des mouvements des doigts." Machines.

The Blind School of Mulhouse has also sent specimens of its work to the Exhibition, a portion of which is shown in the Mulhouse cottage in the park, and the rest in the case Mulhouse Blind School.

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of the Paris blind school (87). The cane, straw, and mat work is worthy of attention, as well as the well-embossed books in Braille's system.

## Prussia.

Prussia.

Although the educational departments of North Germany are well represented in the Paris Exhibition, it is a matter of regret that the great blind institutions of that country have failed to exhibit any appliances for the education of their inmates. In the Prussian schoolhouse, which forms so interesting an object in the park, Mr. Hebold, of the blind school at Barley, exhibits a useful little machine by which the blind can write. It consists of a small desk in wood, a perforated line, which receives a pointed style. The mode of writing is best explained by a glance at the accompanying diagram (*see opposite*).

Hebold's writing machine.

The great difficulty in this method of writing is to teach the blind the necessary form of the letters. The specimens of embossed books, published in Berlin, in the ordinary Roman capital letter, are well and clearly printed. They consist of primary elementary works, and are well adapted for schools. Their moderate size and price are also great recommendations.

## Würtemberg.

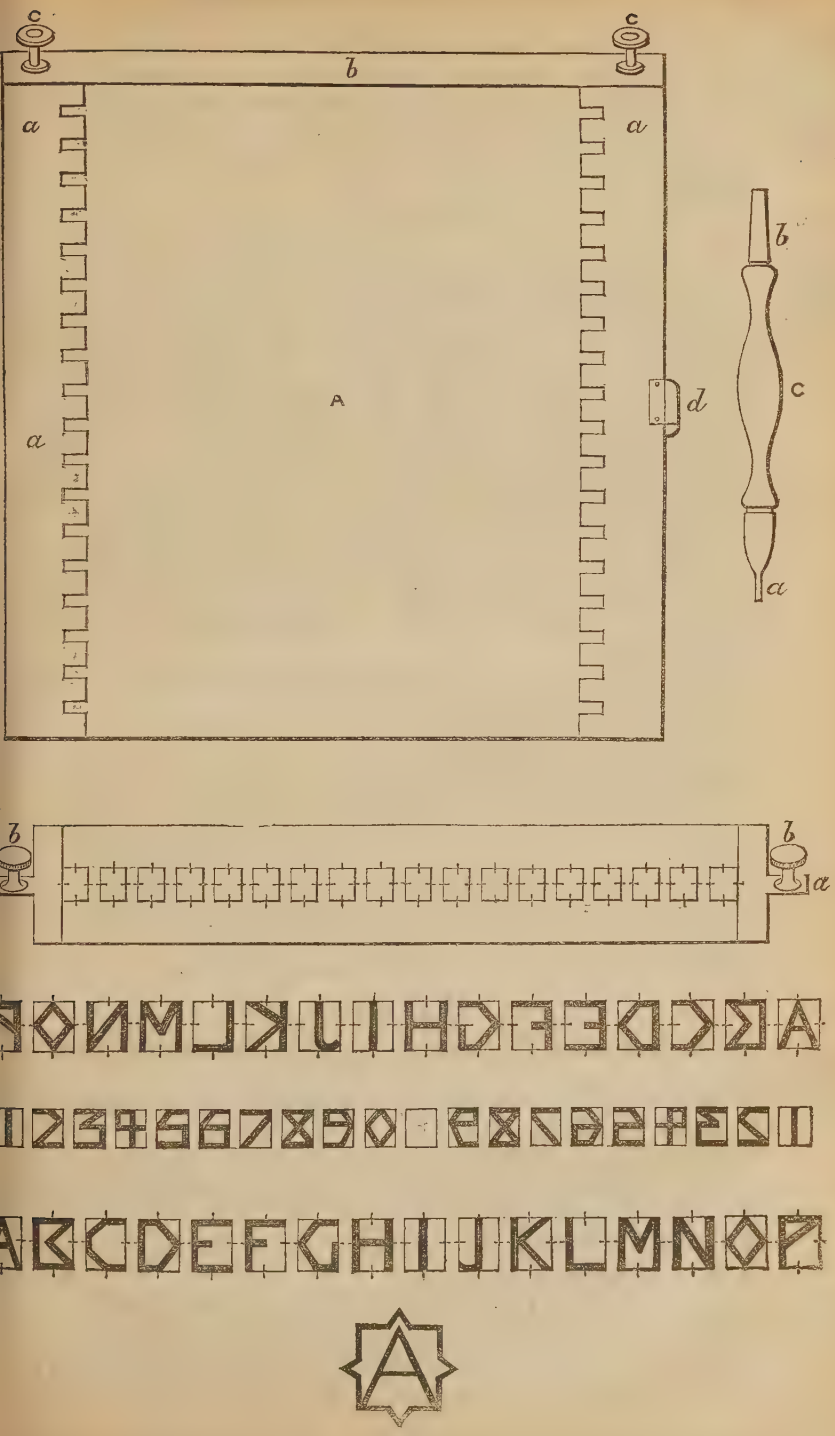
Würtemberg.

Bible embossed for the use of the blind.

One of the most interesting groups displayed under class 6, in the kingdom of Würtemberg, is the collection of embossed books by La Société Biblique de Stuttgardt. It consists of sixty-three volumes of the Bible embossed for the use of the blind, printed in Roman capital type, bound and numbered, price 130f. This collection was commenced in 1840 by the publication of the Gospel of St. Luke, and continued until the New Testament was complete, in 15 volumes, in the year 1859. In the spring of 1863 all the sacred book was embossed, and published in sufficient numbers to satisfy the demands of all the German blind schools.

The embossing was carried on at Stuttgardt until 1856, since which period M. Alphonse Kochlein, himself a blind man, has continued it at the school of Illzach, in Alsatia. Five thousand copies have already been printed—one thousand distributed in Würtemberg, and four thousand throughout the rest of Germany, particularly in Prussia, Saxony, Hanover, Bavaria, Switzerland, Alsatia; a complete copy being also sent to China. The society has sold most of its works at two-thirds of their cost, while the poor and deserving have received copies gratuitously. "The ordinary type in which "these bibles have been printed," says the official report, "is of great advantage to the blind, as they are thus taught

WRITING FRAME OF MR. HEBOLD, OF BARLEY.



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"in the same way as a seeing child. It has a great advantage over the system of Moon, a species of stenographic writing, like that of Braille, as instructors are not obliged to learn arbitrary characters." This library for the blind received honourable mention at the last Exhibition at Munich.

Belgium.

## Belgium.

Liège Royal Institution for the Deaf, and Dumb, and Blind.

The Royal Institution for the Deaf, and Dumb, and Blind, at Liège, is the only Belgian blind school represented at the International Exhibition. Pupils are admitted between the age of eight and 15, and day scholars are allowed to profit by the advantages of the institution. A payment of 375f. is required on admission for the poor, and 450f. for those in a better condition of life. The education for the blind consists of religious instruction, reading, writing, grammar, arithmetic, geography, and music, &c.; whilst that of the deaf and dumb includes "la langue mimique" articulation-drawing, modelling, and sculpture; each scholar being apprenticed to a trade. A night school for old pupils is likewise held within the building. In 1865 the establishment contained 31 dumb boys and 16 girls, five blind boys and four blind girls.

Dumb.—Twelve tailors, eight shoemakers, seven turners, four printers, 16 workwomen.

Blind.—Three upholsterers, four straw-plaiters (boys), four straw-plaiters (girls).

The straw-plaiting of the blind deserves some notice, especially the well-made hats and caps, mats, and small baskets. The tailoring of the dumb pupils is not, however, to be compared to results shown in other foreign schools.

The exhibition is below par, when compared with that of other countries, and lacks that care and completeness so remarkable in the schools of France and Austria.

Holland.

## Holland.

Rotterdam Blind Institution.

The Rotterdam Institution for the Blind is the only Dutch school represented at the Paris Exhibition.

The display is so carelessly arranged, and so few details, as to its organisation and object, are furnished to the jury, that it becomes a matter of impossibility to decide as to its actual condition and progress. A few embossed books, in Moon's artificial characters, printed for the Dutch in England by Mr. Moon, of Brighton, form the only appliances exhibited for instruction.

The industrial results include poor specimens of mats in cocoa-fibre and rope, some fanciful flower-stands in round canework; baskets indifferently finished, coarse beadwork, strung together by the female pupils; large over-shoes made

of list, and a few brushes. The deaf and dumb have also contributed some very elementary specimens of drawing and modelling. It is evident that, throughout Holland, industrial occupation for the blind takes the lead in all their schools and asylums. The jury, therefore, awarded an honorary mention to the institution at Rotterdam, which has only been established since 1858, not so much for its exposed results as for its good intentions.

## Denmark.

Denmark.

Copenhagen Blind Institution.

The Institution for the Blind at Copenhagen is ill represented at the Paris Exhibition of 1867. This is a matter of some regret, as the institution has done, and still continues to do, much substantial good amongst the poor blind of Denmark. It is patronised by the Royal family and the State, and counts amongst its well-wishers and supporters Mr. Schott, Mr. Guldberg, Dr. Melchior, and Mr. Moldenhawer.

Its history.

The institution was established in 1857, by a vote of the Folkething, under the direction of a council of five persons —three appointed by the State and two by the Philanthropic Society. It receives and educates 60 poor blind children between the ages of 10 and 12 years. A payment of nearly 40*l.* a year entitles the richer class to a share in the advantages of the charity. The blind school was opened on Nov. 6, 1858, and has made fair progress though the objects displayed are few, and for the most part unimportant, considering the position of the institution. They consist of specimens of embossed books, well executed in pointed lower-case Roman type, and cheap in price ; the specimen most worthy of notice being a new volume, " Study for the Violin by Spohr," printed at the school by blind embossers.

schools,

exhibits.

The following works have also been embossed in the Braille system:—For pianoforte: Sonatas of Kulhan, Clementi; fantaisies of Mozart, Haydn, Beethoven. Exercises of Czerny. Studies by Lomoine (work 97).

For violin : exercises of Rode and Kaiser.

"Blind Workers" Institution.

There is, likewise, a sister institution in Denmark for " blind workers," which has received a considerable impetus since the opening of the blind school. Established by a charitable society called the " The Chain," in 1811, it has since held bazaars and opened shops for the sale of work executed by the blind. In connection with this charity a preparatory infant school for the blind has been founded, which promises to be a great success.

The specimens of geometrical and general diagrams embossed on paper by the male pupils are clear and well defined, and must be useful aids in the higher classes.

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Guldberg's writing frame.

The writing-frame of Mr. C. E. Guldberg, for correspondence in the ordinary lower-case character by means of a pencil (the blind to correspond with the seeing), is the only apparatus exhibited. It is thus described by the inventor:—"A hand-"guide for writing with a pencil in the ordinary caligraphy "of the seeing." The writing, when reversed, is slightly in relief, but can only be useful in communicating with the seeing. The frame is composed of a little desk, with a slide, which moves from right to left, and *vice versâ*, between two parallel bars of wood. The moveable portion contains an angular and oval aperture, in which letters are formed with the point of the pencil. In this respect it resembles the instruments of Mr. Gall, of Scotland, and Mr. Hebold, of Prussia, and, in common with them, consists of "a hole "which changes in form by means of four slides in which "letters are formed." (*See opposite.*) It is very cheap (4*s.* 6*d.*), can easily be put into the pocket, and is useful for an expert blind man who has lost his sight late in life.

The opinion expressed of this machine by M. Guadet, Chef d'Instruction dans l'Ecole des Jeunes Aveugles à Paris, deserves to be mentioned:—"La machine de M. C. E. Guld-"berg procédé du typhlographe dont elle est une regularisa-"tion ingénieuse, mais aussi, il faut bien le dire, une "complication poussée à un assez haut degré."

There is no opportunity of judging as to the proficiency of the pupils of this school in manual occupations, though it is stated that basket-making and other trades are making progress.

Italy.

## Italy.

Only two Italian blind schools are represented at the Paris Exhibition, those of Milan and Sienna.

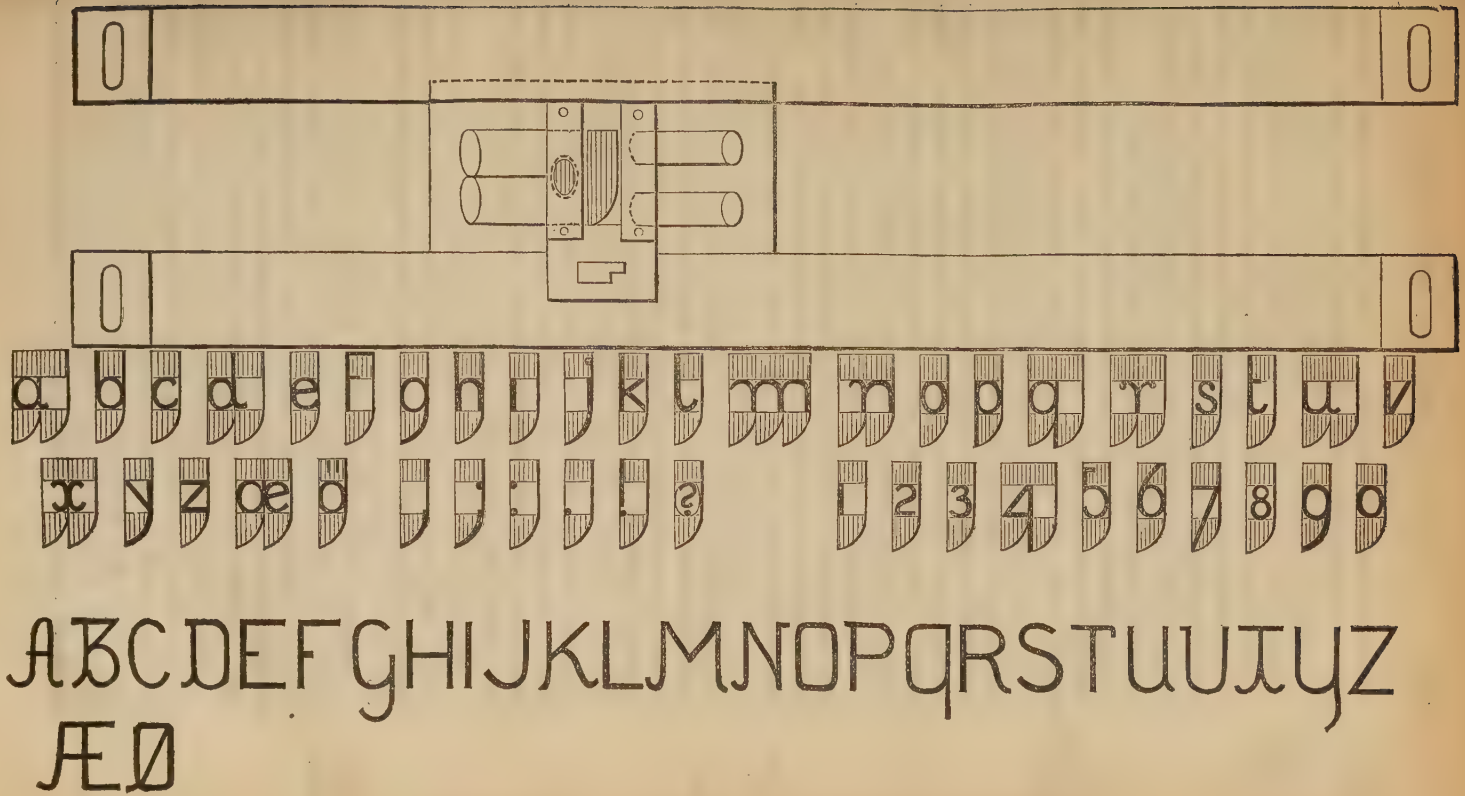
Milan Blind School.

Milan. This school, under the direction of Signor Barozzi, is supported entirely by private charity. It is a fine building, situate in one of the best parts of the town, and contains 100 scholars, varying from the age of 10 to 45. It combines a school for primary instruction, and a normal training school for masters, with pupil-teachers. A high degree of proficiency is attained, both in intellectual progress and manual labour, whilst the musical education has reached a perfection almost equal to that of Paris. Its orchestra, conducted by a blind leader, numbers upwards of 40 executants, and is the great attraction of the establishment. The male pupils are mostly engaged in learning music and French, as manual instruction is made a secondary consideration. They are, however, taught cordwork, the manufacture of nets, chainwork, brushes, baskets, embossed printing, and the

Its primary and normal schools.

Orchestra.

Industrial and other teaching.



WRITING FRAME AND LETTERS.—MR. C. E. GULDBERG, OF COPENHAGEN.

Mr. E. C. Johnson on Means for Instruction of the Blind.

weaving of elastic bandages. The females are employed in similar occupations, but more particularly in the manufacture of worsted carpets. A singular class is held by Signor Barozzi, in which he teaches the form and value of the different coinages of all countries. A well-chosen collection of embossed books, in the lower-case type, is exhibited, including a grammar, theory of reading, national stories, French grammar, selections from Italian authors, arithmetic, geography, principles of music, essay on writing.

Vensali Cesari's embossing and writing frame.

A collection of reports, contributed by Signor Michael Barozzi, contains ample accounts of the condition and management of the school. The embossing and writing frame invented by Vensali Cesari also finds a place here. It consists of a desk-frame fitted with a sliding bar, to which is attached a small moveable plate, with slides, somewhat resembling the machine of Mr. Guldberg, described in "Denmark." It is, however, of so complicated a nature that it can be but of little use except in the hands of an expert.

The specimens of basket-work, string, chair cane-bottoming, and slippers, merit especial attention, as they prove that industrial work is making considerable progress in Italy. The

Industrial work.

most remarkable object, and one that has attracted the especial attention of the jury, is a handsome carpet, made in coloured worsted by a blind pupil of the establishment. It

Carpet.

is unlike those manufactured in England by the blind, being, in fact, a specimen of what is called "berlin-wool work," executed with a needle in stiches, on a moderately fine canvas. There are ten different colours blended into a beautiful design, worked from an embossed pattern on paper. The arrangement of the pattern is by numbers and points embossed on paper—the numbers standing for the colours, and points for the stitches.

The jury awarded the eighth silver medal to this school, which has only been established since 1840, and a bronze medal to the pupil who executed the carpet above referred to.

Sienna Blind School.

Sienna.—The blind school at Sienna is entirely in the hands of a friar named Padre Pendola, and Signor Luigi Tofani. These two men have devoted their time and attention to the cause of the blind and deaf and dumb, and from their own private means, together with occasional help from the Government, have succeeded in carrying on their charitable work. At the present time sixty blind pupils are fed, lodged, clothed, and instructed in this school. The exhibition of results is not favourable when contrasted with the great school of Milan, yet it is worthy of notice as being the creation of these two gentlemen. Deaf and dumb children are

also lodged, clothed, and instructed in the same establishment; some of whose works have attracted attention, particularly the wood-carving, framework, and engraving, for which bronze medals have been awarded.

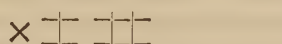
## Sweden.

Sweden.

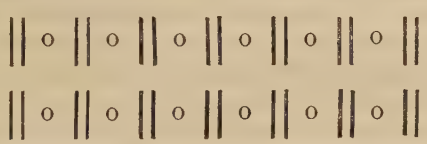
In the picturesque house allotted to the products of Sweden and Norway, in the park of the Exhibition, some very remarkable manufactures of the blind, and various educational instruments, are exhibited; amongst which, list-shoe work, string, knitting, and baskets may be mentioned, though for the most part clumsily but strongly made. Several embossed books are also exhibited in large lower-case and awkward-looking Roman type, each letter printed at great intervals, and occupying much space. The embossing, however, is sharp and well raised, and easily felt. There are also rough writing and calculating boards, in which arbitrary characters somewhat resembling the following are employed:—

Remarkable manufactures.

Writing and calculating boards.



From the want of a proper attendant to explain the working of these frames, it was difficult to test their utility. One in particular consisted of a number of longitudinal and circular holes, ranged alternately, with type of corresponding dimensions, which, when fitted, denoted sentences, arithmetical sums, or algebraic figures. The board presents somewhat the following appearance,



and is not unlike the ordinary calculating-board used in the Alston Asylum at Glasgow. The maps and other writing-frames are of the pattern used in France, and therefore present no originality of design. The jury awarded a medal to this section, and was informed that a small blind school existed in Stockholm with a large parent institution in Christiana, under the direction of Messrs. Roggew and Angell.

## Spain.

Spain.

Two schools are represented from this country—viz., those of Madrid and Barcelona.

The blind school at Madrid contains an equal number of blind and deaf and dumb pupils, under the superintendence

Madrid Blind School,

Mr. E. C. Johnson on Means for Instruction of the Blind.

of M. Ballesteros, who, after much personal labour and indefatigable zeal, has obtained considerable success. The description of this charitable work is graphic and touching, and merits the reward it has attained.

its history,

He tells us that, "in 1834, he was touched by the wretched "condition of many poor blind beggars who infested the "streets of Madrid, and who shocked the ears of the passers-"by with their insulting language and disgusting bearing." Having had considerable experience in the education and treatment of the deaf and dumb, he determined to try his hand at the blind; and, in co-operation with the Société Economique de Madrid, partially educated some eight or ten blind children, at his own expense, in reading, writing, arithmetic, geometry, and geography. The Queen of Spain then gave her patronage to his school, and in 1836, 26,000 livres was voted for its maintenance. It appears that since that period suitable premises have been obtained in Madrid, and that all modern appliances have been introduced with complete success. Amongst the apparatus exposed in the Exhibition are various writing and embossing frames used throughout France and England; but, as they are not of Spanish invention, it will be unnecessary to describe them in detail. They indicate, however, a strong desire on the part of the Spanish Government to employ all available aid from other countries for the use of their own people. The ordinary Roman letter, and M. Braille's system of writing and printing, find equal favour in Spain. Several books on the former system are exhibited, well and cleverly embossed by the pupils of the school, particularly a "System of Musical Instruction for General Use." The books in Roman capital and lower-case character include some well-selected editions of standard authors in music, geography, and religion. The manufactures of the pupils are confined to the making of slippers, a few poor specimens of turnery, together with cord and string work. Music appears to form a considerable feature in the establishment, though it has not attained to so high a position as at the Barcelona school.

and exhibits.

Some of the works supplied by the deaf and dumb inmates of the same establishment are worthy of notice; to which, and the products of the blind, the jury awarded honourable mention.

Barcelona Blind School.

The blind school of Barcelona.—It would be difficult for a stranger to judge of the working of this school by a casual inspection of the very poor specimens of manual work exhibited at the Exhibition. There are many embossing frames of French and English design, some good books, printed in raised lower-case type, arithmetic boards, speci-

mens of embossed correspondence, and musical composition. A violin, manufactured by one of the blind pupils, is by far the most curious of "les travaux d'élèves;" whilst the worsted and string work is insignificant when compared with those exhibited by the blind of other countries.

The author feels that he cannot do better than quote from one of his own works* the personal impressions which he received whilst visiting this school a few years ago in company with his blind friend, the late Viscount Cranborne, whose untimely death was a sad loss to the indigent blind of England.

At that period the school of Barcelona had made great progress in the musical instruction of the blind, and had produced some remarkable musicians. It may be said to have given the impulse to the London School for the Indigent Blind in the formation of their orchestra of blind musicians, which has since been so peculiar and interesting a feature in that establishment.

Report of visit in 1854.

"During the summer of 1854 I visited the blind school of Barcelona, the most complete of its kind throughout Spain, and was much pleased and astonished at the progress made in the education of the blind, The school is situated in the Platza Santa Anna, in an old convent, which has been allotted by the Government to the uses of the Corporation of Barcelona, who have established there a very large school, divided into several sections, for the general instruction of the children of young and of more advanced ages, and likewise for those afflicted with partial or total blindness. Unlike charitable schools in other countries, it is devoted exclusively to mental and musical instruction, neither food nor clothing being found; whilst the attendance, not being compulsory, is somewhat irregular, the number of pupils depending greatly on caprice, the state of the weather, or extraneous circumstances. The hours of attendance are nominally from nine to twelve and from three to six, with several intermissions on fête days and holidays, which, being of frequent occurrence in so Catholic a country as Spain, makes it difficult for visitors to find both masters and pupils at work.

"The establishment will accommodate a large number of scholars, though there are but about sixty or eighty blind pupils, who attend irregularly. Forty-five to fifty males and twelve to fourteen females is the ordinary number that can be got together, except on particular occasions. The

* "An Inquiry into the Musical Instruction of the Blind in France, Spain, and America," by E. C. Johnson, Esq.

MR. E. C. JOHNSON ON MEANS FOR INSTRUCTION OF THE BLIND.

locale is very Spanish, being fragrant with the fumes of garlic, and very al fresco as regards furniture and school accommodation. On the boys' side there are several small cells, once the sleeping-chambers of bygone friars, but now devoted to the practising on one or other of the many musical instruments on which the pupils are taught. There are three larger rooms for the masters, who give separate instruction to their various classes in music—that being the chief feature in the education—a greater portion of time being devoted to its acquirement than to anything else. Indeed, as far as the males are concerned, there is little else in which they are proficient. The head master or director of the school spoke French, and therefore was enabled to carry on a conversation with me. I attended his class of instruction in the morning and was astonished at the proficiency of his pupils. He began to teach a portion of a mass by Palestrina, and had, ere I left, almost succeeded in perfecting them in the task. This little troop consisted of two violins, a cornet, clarinet, French horn, and two flutes. The music was called out by the professor : those who understood notes or written music being told the notes they were to produce, others only taking up the air by ear. Little is done to teach the full theory of music, though in a few instances it has been done ; and it is now in contemplation to effect so desirable an end more generally. The acute ear of the Spaniard and his innate love of music seem here doubly developed, and to become a source of unceasing amusement. There is a degree of cheerfulness and vivacity about the Spanish blind which surprised me ; they seem less helpless than their northern brothers in affliction, whilst their gaiety of manner is no doubt dependent on the vivacity of the national character. Their deportment is very Spanish, and they possess a self-confidence and a nobleness of bearing seldom found among the inmates of similar schools in other parts of Europe. They appear to belong chiefly to the lower orders, though some are well dressed and clean, while others forcibly reminded me of the acute, handsome, and sunburnt subjects immortalised by the brush of Murillo. The two under masters also gave instruction in music, and in the other branches of education ; whilst a very intelligent priest attended to the moral and religious training of the little community.

" The music is not only read to the younger pupils, but intoned by the masters, whilst many of the learners write down on paper, by means of the frame and style of M. Braille (the French dotted system), the notes they have to commit to memory. Great care is taken that part music shall form

the chief subject of instruction, as the directors wisely foresee that if the blind are taught to play out of class, they will only, in after life, become itinerant street-players, and crowd the town as beggars. Many pupils write fluently on the Braille system, though there seems a great objection to its free adoption, arising from its arbitrary character; and they only wait the arrival of machines from England to commence work with our ordinary writing-frame. No trade or other manual employment is taught amongst the males; and, indeed, it is feared that they would be little inclined to avail themselves of such instruction if offered to them. It is, however, in contemplation to establish a more permanent school, after our English models, when it is expected that the Government and municipality will not only help it with funds, but will cause the pupils to be instructed in industrial work. At present the Spanish Government only affords the building, the town furnishing the necessary means of carrying on the schools.

"The most intelligent male pupil was one Casa Pugiberti, twenty-one years of age, and blind from birth. He had been three years under instruction—wrote well both prose and music—played on two instruments—was well informed—and of rather a better rank of life than his fellows. He appeared much delighted at the visit of an Englishman, and was very grateful for the interest taken in his doings.

"The female portion of the school was on a much smaller scale than the male. The instruction was conducted by a mistress, whose sole duties consisted in teaching her pupils knitting, making beadwork, sewing, and netting. A peculiar manufacture of gimp was carried on by one pupil which, I think, might be introduced into our English schools with advantage. It seemed to be very easily and quickly performed, and to be a pleasant work. One old woman was very dexterous with her fingers, and threaded her needle with her tongue, as other blind persons frequently do. The priest above-mentioned instructed the females in what seemed to be a mere repetition of prayers and hymns, and the topography of the town. But he had made some excellent raised maps in wood and cardboard, and has thus taught his pupils to find their way amongst the intricate and narrow streets of Barcelona. There seemed to be an indisposition to introduce embossed books; though, after a long conversation with this priest, which was interpreted by a gentleman, a member of the municipality of Barcelona, he appeared to concur in my views of a literature for the blind, and begged me to send him some type from England, that he might print books on religious subjects in the Roman capital letter. This has since been carried out.

Mr. E. C. Johnson on Means for Instruction of the Blind.

"The great evil of the whole institution is the admission of cases not totally blind. The same objection holds good here as in England; as the seeing lead the blind into mischief, and rather trust to what little sight is yet left to them, than to proper oral and manual instruction. Some of the cases possessed a considerable amount of sight, whilst others were completely blind; the blind, as usual, being the more patient and persevering, and becoming the chief proficients in their art.

"The band consisted of twenty-three blind musicians—viz., ten violins, two contrabassi, two clarinets, two horns, two cornets, two flutes, one trumpet, one fife, and one drum. The selection of music consisted of lively airs and operatic morceaux, which were performed with great regularity and precision. The performance of a boy of ten years of age on the flute and the fife was very surprising and perfect of its kind; whilst the violins and cornets were handled in a manner that did the players great credit. The band was conducted by the chief professor, who beat time on a piece of board, occasionally walking amongst his blind pupils, and giving oral instruction as he passed. I received the very greatest attention and civility from the Court of Directors, all members of the municipality of Barcelona, none of whom had ever seen a blind school out of their own country, and who were therefore anxious to have the opinion of any one at all connected with a foreign school."

America.

## America.

Dr. Howe's literature for the blind.

Dr. Howe, of Boston, has contributed specimens of his literature for the blind, printed in what is called American character, viz.—small lower-case type. His books are so clearly and beautifully printed, and the texts so well chosen, that it would be difficult to speak in too high terms of his collection. The number of volumes, and the full description of Dr. Howe's labours, were so fully recorded in the report of the juries of our first Exhibition, that it will be unnecessary to recapitulate them here. The jury of 1867 have, however, marked their sense of Dr. Howe's valuable labours in the cause of the blind by according to him, as director of the Boston school, a silver medal.

England, almost unrepresented.

## England.

England, which is so rich in institutions for the blind, is almost unrepresented at the Exhibition. This is attributable to a want of harmony and concert amongst the various schools and societies in England; to the dread of intrusting their interests to other hands than their own; and to the

opposition which is so strong an element amongst the lovers of particular systems for teaching the blind to read. Neither the noble School for the Indigent Blind at Southwark, with its 200 pupils, its grand tradal resources, and its wonderful educational appliances, nor Miss Gilbert's society, with its host of blind workers, have thought proper even to apply for space in the Exhibition building; while the St. John's-wood and Bristol blind schools are nowhere to be found in class 89. This omission has placed the English blind in a very unfavourable position on the Continent.

Two exhibitors have however feebly proclaimed the nakedness of the land. They occupy Nos. 4 and 8 in the catalogue and have been passed over by the jury as unworthy of special praise.

James Gray's map.

No. 4. James Gray.—A map in relief for the blind, consisting of an ordinary printed wall-map, with the divisions of the countries, counties, rivers, &c. marked with different sized string, gummed on the paper. As the work of a blind man, it is curious and interesting.

Tangible geography.

It has been remarked that Tangible Geography seems to have made but very little progress of late years. Although a blind man may gain a tolerably correct idea of space, form, and even colour, few attain a marked proficiency in it. The resources, position, and size of countries can be mentally appreciated; but the reduction of large tracts of country to the small scale of a map baffles the blind man more than any other study. The question arises whether he can at all realise by touch, or take in mentally, what the seeing conceive when looking on a flat painted surface. Amongst the English blind this is far from the fact; they learn the names of cities, districts, mountains, and rivers, but fail to carry in their mind's eye the whole scheme of a diagrammatised country. In the writer's experience, founded on the observation of the habits of a very large blind school, instruction in mental geography is far more useful than even the simplest of raised maps.

Mr. Milford's vertical system of reading.

No. 8. Milford's apparatus includes a "New and Easy Method of Reading for the Blind," in Roman characters, on a vertical system; and a "Hand-Guide for Writing."

"In this system," says the author, "the reading is down-
"wards, the letters being arranged like figures, one under
"the other; the words being separated, as usual, by spaces.
"If the word does not finish at the bottom of the column it
"will continue on to the next. The blind reader, when he
"gets to the bottom of a column, will run his finger up the
"channel made by the rows of letters, which will guide him

MR. E. C. JOHNSON ON MEANS FOR INSTRUCTION OF THE BLIND.

"without difficulty to the next. Feeling the letters from "the top, they are more easily recognised from the side."

Mr. Milford tells us that the vertical system is proposed because it possesses mechanical aids in a greater degree than any other known plan.

"1st. The letters, on this system, are always at equal distances from one another; also, the spaces between the words are alike.

"2nd. Each page will contain the same number of columns throughout the book. These will be found great helps to the reader.

"3rd. According to the present system of reading in horizontal lines, the motion of the hand to and from the body is fatiguing; upon the vertical or downward plan, it would be much reduced and more natural, therefore less fatiguing, the arm having little or no motion from the body.

"4th. The sensitiveness of the feeling is impeded by the side motion, the edge (or less sensitive part) of the finger coming first in contact with the letters. In the vertical plan the fore-finger would be employed alone; and this finger, I think, will be allowed by all to be the most sensitive. At the same time the top of the finger would come directly over the whole letter, which would therefore be the more easily recognised, no other letter touching it on either side.

"5th. In the horizontal system, when Roman characters are used, the letters are approached sideways—the most difficult for recognition. In the vertical plan the letters are approached from the top—the most easy of recognition. This I consider a great advantage over the side motion in many of the letters—such as B, D, E, F, I, K, L, M, N, H, R, U. These, when approached sideways, would at first appear like i's to the touch, on account of their straight sides. As an instance of a small letter, take *m*; the first line to a blind man (reading horizontally) might appear to be *r*; he then moves on to the second, which will make it appear an *n*; and it is not till he feels the third arm or stroke that he knows it to be an *m*; whereas with the downward motion the bows would have been felt at one and the same time. The same may be said of most other letters.

"Some people will say this is all quickly done; but no matter how quickly, still it has to be done, and a blind person reading will only pass one bow at a time, and his mind must add together the several sensations before he can ascertain the letter. But in approaching from the top the letters are more easily recognised and more quickly felt by the most sensitive part of the fore finger."

" Any other type may be printed on this system with advantage and any abbreviations may be introduced."

SPECIMEN OF PRINTING.

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Books and other exhibits of Mr. Milford.

Mr. Milford deserves considerable credit for his philanthropic views, particularly as he is a champion for the use of the ordinary type of the seeing. His books are well and clearly printed, and the type used is of the same form as first introduced by the Rev. W. Taylor of Worcester, in printing some of his early books for the blind at the press of Messrs. Taylor, Queen-street, Lincoln's-inn-fields.

Mr. Milford is not so happy in his writing machine for the blind. It is too large and expensive to be of practical utility in ordinary blind schools. His telegraphs for the deaf and dumb are, on the other hand, very useful little instruments, and both portable and moderate in price.

## Report on Libraries and Apparatus used in the Instruction of Adults.—(Class 90.)—By the Rev. M. Mitchell, M.A., and one of Her Majesty's Inspectors of Schools.



No special peculiarity for working-class education.

In reporting on the special objects exhibited in Class 90 of the Paris Exposition considerable difficulties are experienced, as in reality the principal subjects of the class are not such as come under class exhibits. Libraries and material for the instruction of adults, whether in the family, the workshop, or societies, differ in no respect from the libraries of ordinary life, or the materials of ordinary school teaching. Every adult who is ignorant must be taught as an ignorant child is taught, and with the same material and by the same processes. Every educated adult of the working classes will make use of the same books as other educated people, either for the pursuit of such special branch of knowledge as he may require, for general education or for pleasure. There is, therefore, no special peculiarity for working class education. This report, then, will be confined mostly to relations on the progress of education amongst the working class; the statistics of the several counties that have exhibited, as far as I have been able to secure them; reports on the societies for mutual education of each State, the progress that has been made, the establishments formed, and in some cases of artistic production, the results obtained. I shall show what other nations are actually doing, by what means they propose success, what are the actual results, why some people succeed in a certain progress, why others are kept back, either retrograding, or not making those advancements which the age and general spirit of the time require.

English education defective.

It is especially important that England should address itself to this knowledge, as an opinion prevails that the last ten years have not developed so much artistic and mechanical power in our manufactures as has been the case amongst other nations. A very deep feeling pervades the minds of many of the jurors of classes that the education given in other countries, specially adapted to manufacturing life, is very much more extensive and very much more real and suitable than is to be obtained amongst ourselves, and that it would be well for us to examine what is the best in other countries, that we may adopt their excellencies and remedy our own defects.

Rev. M. Mitchell on Libraries, &c.

The true education of England.

In such examinations jealousy on either side should be carefully avoided; and if we, comparing ourselves only with ourselves, are not always wise, yet we should remember that a depreciation of English art and education from mere inspection of the Paris Exposition may lead to very unjust conclusions. The intelligence of a country is not altogether best displayed in exhibitions. Certain excellent qualities, no doubt, are developed; certain arts and manufactures; certain qualifications and teachings; but the spirit and power of a nation, the development of its mental activity, its force and strength, are best shown in the energy of its people, ramifying into all parts of the globe; in its extensive and numerous factories, in its exports and imports, in the admiration of other States for its institutions, in its power of self-government and control, by the conduct of the people when in masses, and by the numerous daily and weekly journals supplied to an ever-increasingly intellectual population such as no other State can show. These real results of education are worth a thousandfold more than all the copy-books or artistic drawings in the world. These evidence a people by no means uninstructed in the higher and more elevated moral and civil duties of citizenship; and that country cannot be said to be indifferently taught whose people, for the most part, have inwardly grafted within them the idea that respect for law and self-control in the subject are of more consequence to a State than power in the prince or ruler.

Still, there is much yet to be done before we ought to rest contented. A work has been commenced, progress has been made, the nobler branches of education as a rule, have been acquired—the higher parts of the law. Why should the mint and cummin be neglected? And if our trade suffers from the want of art-education, as is generally thought by those that ought to think; *i.e.*, people who really understand the matter—it will be surely wise not to blind ourselves to the fact, but to take all possible means to remove the stigma.

Opinions as to deficiencies.

The president of the Institute of Civil Engineers at the dinner of that society last May, stated:—"I am reluctantly "compelled to admit that in machinery a more rapid ad- "vance towards excellence and a greater number of new and "successful combinations have been made by foreigners "during the last ten years than by the people of this "country." And the special correspondent of the *Times* (May 13) reports that "at the French Exhibition the French, "the Austrians, and the Belgians have not only come up to "us, but have beaten us in ironwork. In textile fabrics a

" similar inglorious tale has to be told. In our woollens we " show scarcely any advance, and in our silk manufacture we " have decidedly retrograded."



Viewed in the light of exhibiting the vast reading powers of the nation, we may point to that large collection of daily and weekly journals, a single number of each of which occupies so conspicuous a place in the English department. It tells a great tale, the number of thousands of every sort of paper, with political and scientific, and, in fact, all knowledge thus scattered broadcast through the length and breadth of the land; and it affords no small proof of the actual morality of the nation that, of all this vast number of journals, the very smallest minimum alone is found that infringes the rules of morality or inculcates doctrines subversive of Government or good order.

Newspapers and periodicals.

Among these journals, perhaps the one of most educational value is the *Illustrated London News*. The advantage of aiding the description through the picture is so great that one might conceive that, by aid of this journal, anyone of ordinary sense, however secluded, but able to read, might perfect his knowledge himself, and in the course of years have picked up more acquaintance with every subject of information than in the last century even the literary classes could obtain. It is gratifying to state that this periodical is extensively circulated amongst their schools by the clergy of all denominations.

This report on Class 90 is necessarily very imperfect; circumstances rendered it impossible to complete it satisfactorily. There were great difficulties, in many cases, in discovering the exhibits and in finding the proper persons to display and explain their merits; and thus many valuable objects have been, perhaps, unfortunately omitted. Our report relates, also, to little except the expositions of the chief European countries. The Asiatic and African contributions are not numerous, nor those of America; while the languages of Turkey and Greece preclude the ordinary visitor from deriving any other pleasure than that of curiosity to see the productions of each country. I shall take the exhibition in its order of place in the building, beginning with France and ending with Great Britain.

It will be found that considerable similarity of motive actuates all the authorities and all branches of society among continental nations. They all use one word, "progress;" they all endeavour to extend education amongst the people, to all its members, and to improve that education in all its forms and subjects; they are not content with the minimum, they demand and enforce the maximum; they suffer no

Motives of action amongst foreign states.

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class jealousies to interfere; they believe in education, and they confirm their belief by the testimony of its good results —of the moral as well as intellectual advancement of their several peoples.

## France.

Progress of French education.

The French Education Department of the Exposition counts 500 exposants; it 1862 it counted 180; and on this occasion twice as many sought admission in vain. This branch of the Exhibition establishes two grand facts:—1. Great progress in the last five years; and, 2. Much greater to be expected from present institutions for the future.

While the buildings and materials of instruction have increased and improved, the instruction itself has not remained stationary. Its subjects have been enlarged by making instruction compulsory in several branches to this date only recommended, and by the better methods of teaching now introduced. Instruction is given in agriculture, and horticulture, and gymnastics; but more particularly has it advanced in respect to adult education, only lately offered to those who either by their own or parents' fault or exigencies have grown up in ignorance; and in its higher branches also to those desirous further to improve their minds. The recent introduction of living languages, of commercial geography, of laws relative to workmen, and of industrial economy, will give an immense impetus to education all through the country.

Art schools.

In respect to art schools, the workmen comprehend no less than the masters that the destiny of one part, at least, of their occupation depends upon the superiority of their taste, and it is the strength of this shared opinion of workman and employer that has compelled the foundation of technical schools to supply the inefficiency of apprenticeship.

Libraries attached to schools.

The object of this technical teaching is to prepare for a certain profession or trade, &c. It is, in fact, an apprenticeship. Education, however, is little without books; hence the foundation of libraries. There are 8,000 in France, lending 500,000 volumes a year, attached to communal schools. These are supported by the State, and aided by the exertions of individual societies.

Many publishers have commenced issuing very cheap, excellent libraries adapted to this use. They include most of the classical works of their own language, together with many translations from Greek, German, Roman, and English authors.

Enlightened action of M. Duruy,

A very important step is in progress in France, through the influence and position of M. Duruy, the Minister of

Public Instruction, to whom France already owes so much. He found that the French language was unknown in many districts of France, whose inhabitants speak only a patois, entirely their own. He now requires that French shall be taught in all the schools. Again, he has considered that France is bordered by several nations, and he is taking steps to have the teaching of the neighbouring language in each communal school. Thus the east and north learn German: the south, Italian and Arabic; the west, Spanish; and the north-west and seacoasts, English. It is a great satisfaction that France possesses so enlightened a Minister, and to know that he will not be thwarted by the feeling either of the ruler or the people in developing his noble plans; for France has begun to believe in free trade, and to act on that belief. Free trade is commercial rivalry and contest, and the crown of victory will be gained by that people whose industrials are the most intelligent and laborious.



Minister of Education.

Very ample reports of the state of education in France, in four volumes of most complete and well-arranged statistics, leave nothing to desire in respect to information upon its condition. Elegantly-bound copies of these and former publications of the Minister of Public Instruction will be found in the educational French department. They contain accurate accounts of each of the sixteen academies, extended over the whole of the country; maps also of educational progress, similar to one originally produced for our own country by the late Mr. Fletcher, Her Majesty's inspector of British schools, which once attracted so much attention.

Statistics of French education.

It appears that in the 37,510 communes of France there are 694 which possess no school; but considerable progress is being made to fill up this gap, as in the last two years schools have been built in 162 communes. Altogether in the same period there have been erected in France 1,202 schools, and 135,014 pupils have been added to her scholars.

After inquiries, it has been ascertained that of the 4,000,000 children, between 7 and 13 years of age, rather less than 700,000 do not attend primary schools; in 1865 it was found that 440,000 received no instruction at all, so that 250,000, in round numbers, have received instruction either at home or in establishments of secondary instruction, or from illness, &c., were incapacitated, or, perhaps, were only just seven, or had left school before 13 years of age.

In 1865 the half of the children attended the whole year at the schools.

On Dec. 15, 1866, there were 28,546 evening classes. In the last year 600,000 adult scholars attended these classes,

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of whom more than half either acquired entirely or completed the elementary education given in the primary schools. To establish the necessity for adult schools the Minister, M. Duruy, obtained statistics which proved that the mean for all France of those who did not sign their names at marriage was for men 25·88 per cent.; for women, 41·02—the general mean being 33·45 per cent., or as nearly as possible one-third of the population. But in certain departments the number amounts to 51, 61, 67 per cent. men, and 75 to 80 per cent. women in that deplorable state. The Minister winds up an admirable resumé by detailing improvements in course of being effected, which will enable every subject of the empire to attain education, at least as far as primary instruction is concerned—that power so equally indispensable for all moral excellence as for all professional progress.

Duties of the State.

On the Administration, he adds, devolves the care of multiplying normal schools, of ameliorating instruction, of perfecting the methods, of rendering the teaching more practical, producing better results, increasingly adapted to the wants of the rural populations, and more especially to elevate the schools for girls from the inferior position they at present hold; for these young girls will be one day mothers, and it is upon the knees of the mother that the child receives its first best lessons. The report is divided into two parts, 1, public; 2, free education.

Part 1. State education.

Part 1. Public or State Education.—The number of schools in the communes in 1865 was 38,629:—

| | | |
|---|---|---|
| Held by laymen | 19,044 | Boys. |
| By congregationists | 1,907 | |
| By laymen | 14,469 | Mixed. |
| By lay-females | 1,647 | |
| By female congregationists | 1,099 | |

| | Schools. | Boys. | | Girls. | | Total. |
|---|---|---|---|---|---|---|
| | | Paying. | Gratuitous. | Paying. | Gratuitous. | |
| Ecoles Laiques | 35,560 | 1,176,491 | 512,778 | 236,902 | 76,869 | 2,003,049 |
| Ecoles Congregationists | 3,069 | 113,634 | 208,570 | 18,509 | 7,901 | 420,614 |
| Total | 38,629 | 1,290,125 | 793,348 | 255,411 | 84,770 | 2,423,654 |

The number of teachers equals the number of schools.

The number of girls' schools is 14,721; Laiques, 6,399; Congregationists, 8,322.

| | Number of Children. | | Total. |
|---|---|---|---|
| | Paying. | Gratuitous. | |
| Laiques | 222,923 | 114,381 | 337,304 |
| Congregationists | 342,723 | 373,861 | 716,584 |
| Total | 565,646 | 488,242 | 1,053,888 |

The congregationist schools are those conducted by religious bodies; and these tables show that two-thirds of the girls are included in these schools, while only one-tenth of the boys attend them.

The number of infant schools is 2,484; 567 under laymen, 1,917 by religieuses:—

| | Boys. | | Girls. | | Total. |
|---|---|---|---|---|---|
| | Paying. | Gratuitous. | Paying. | Gratuitous. | |
| Laiques | 8,014 | 30,151 | 8,394 | 24,288 | 70,847 |
| Congregationists | 27,532 | 106,940 | 30,617 | 108,452 | 273,541 |
| Total | 35,546 | 137,091 | 39,011 | 132,740 | 344,388 |

The total expense of primary instruction amounts to 70,405,125f. 25c. The 25c., about 2½*d.*, is amusing after 70,000,000f. Towards this expense the payment of scholars has been;—

| | Francs. |
|---|---|
| Boys, or mixed | 14,351,287·43 |
| Girls | 4,913,225·15 |
| Infants | 351,666·16 |
| Adults | 348,883·98 |
| Total | 19,965,062·72 |

*i.e.*, in round numbers, about 800,000*l.* out of the 2,800,000*l.* of the whole.

For ordinary expenses—

| | Francs. |
|---|---|
| The communes have furnished | 15,943,534·32 |
| The departments | 4,503,575·06 |
| The State | 4,108,881·06 |

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And for extraordinary expenses—

| | |
|---|---|
| The communes - - - | 9,800,034·23 |
| The departments - - - | 1,036,714·69 |
| The State - - - - | 2,066,364·99 |

The remainder is provided by legacies, donations, &c.

Part 2. Private education.

Part 2. Free schools, or not connected with the State, there were in the year 1865—Boys, 2,979; mixed, 541: Total, 3,510. Of these 2,864 are conducted by laymen, 646 by congregationists. They are attended by:—

| | Boys. | | Girls. | | Total. |
|---|---|---|---|---|---|
| | Paying. | Gratuitous. | Paying. | Gratuitous. | |
| Laiques - - | 123,271 | 10,101 | 3,096 | 803 | 137,271 |
| Congregationists - | 34,757 | 55,190 | 728 | 1,298 | 91,973 |
| Total - - | 158,028 | 65,291 | 3,824 | 2,101 | 229,244 |

Girls schools:—

| | No. | Paying. | Gratuitous. | Total. |
|---|---|---|---|---|
| Laiques - - - - | 6,983 | 266,881 | 19,028 | 285,909 |
| Congregationists - - | 5,856 | 287,037 | 156,738 | 443,775 |
| Total - - - | 12,839 | 553,918 | 175,766 | 729,684 |

Infant schools:—

| | No. | Boys. | | Girls. | | Total. |
|---|---|---|---|---|---|---|
| | | Paying. | Gratuitous. | Paying. | Gratuitous. | |
| Laiques - - | 396 | 7,885 | 2,233 | 7,403 | 1,940 | 19,461 |
| Congregationists | 692 | 10,026 | 15,474 | 11,341 | 18,078 | 54,919 |
| Total - | | 17,911 | 17,707 | 18,744 | 20,018 | 74,380 |

Of 4,436,470 children who have attended school, 2,826,952 have paid, and 1,609,518 been received freely or gratuitous.

In 1865, 657,401 children left school, of these—

| | |
|---|---|
| Did not know how to read and write - | 91,170 |
| Could read and write only - - | 170,838 |
| In addition, knew arithmetic - - | 286,202 |
| Had general instruction - - - | 109,191 |
| Total - - - - | 657,401 |

Of these, the two first classes, making a total of 218,602 or 34 per cent., *i.e.*, one-third of the whole, receive so little instruction that in a few years they will have forgotten all they ever learnt.

To diminish this ignorance adult schools are now much encouraged, and have made extraordinary progress. In 1863-4 there were 5,623 schools; on January 1, 1867, they amounted to 28,546, *i.e.*, an increase of four-fifths.

The most enlightened populations of France are those bordering the Rhine; the least instructed those of Brittany, the centre, the Landes, and Corsica.*

Summary.

The reports upon these adult schools have been lately thus summed up by M. Duruy, Minister of Public Instruction, at the distribution of prizes awarded by the Polytechnic Institution. It appears that 40,000 teachers have opened 32,383 evening schools, at which 830,000 adults attended. More than a third of that number were absolutely illiterate, or very nearly so; 23,000 only left the schools in nearly the same state of ignorance as when they entered; but all the others—that is, more than 800,000—acquired the elements of knowledge. Nearly 13,000 teachers gave their gratuitous services; 9,000 spent out of their own pockets a sum of 235,000f. to promote the undertaking; 10,000 municipal councils granted funds during the present year; and the total amount obtained, exclusive of the State subsidy, was 1,860,287f. Having stated the methods of examination, he observed, writing, orthography, and arithmetic are in progress, and so are morals; for these young men, for the greater part, consented to stand the test of examination only from a grateful feeling towards their teachers. M. Duruy further observed that, owing to various causes, but especially to popular instruction, the moral habits of the population have greatly improved. (*Times*, Friday, May 24, 1867.)

Reports on individual establishments.

After thus reviewing the whole state of education in France, let us now proceed to describe some individual establishments.

Ecole Centrale d'Architecture.

A sort of branch of the Ecole des Arts et Métiers, the Ecole Centrale d'Architecture, 59, Rue d'Enfer-Ancien, Hôtel de Chanlues, founded and opened in 1865, is one of

* I cannot sufficiently express my obligations to M. Charles Robert for his general politeness in every matter relative to the subjects visited by the jury, and am further much indebted to him for furnishing the four large volumes from which the above statistics have been culled. M. Robert is the secretary of the department, which must owe much to his intelligence, activity, and zeal. He was also the president of the jury of Class 90, and occupies a very high position in his country, being Conseiller d'Etat and member of several orders.

the most interesting establishments of Paris formed in the last 10 years. It is under the patronage and assisted by the influence of the very highest authorities. It is an especial object of attention to M. Duruy, the very able and enlightened Minister of Public Instruction; and M. Charles Robert, the secretary of that department, well known for various works on education and of very advanced views, has constantly attended the meetings of the schools, representing at once the Minister and his own opinions. It is sufficient to manifest the esteem in which the idea and method of carrying out the institution is held to state that M. Dupont de l'Eure is the president, and made most valuable addresses at the commencement of each session—valuable in every point of view, applying not merely to art as practised in France, but to general art all over the world.

It is only necessary to name MM. Lecoq de Boisbaudran and Pierre Chabat, and MM. Viollet le Duc and Bellange, as their colleagues to prove the great importance attached in Paris to this establishment.

M. Emile Trelat is the director, assisted by a staff of more than 30 eminent professors.

The nature of the course of instruction will be best understood by naming the chief subjects to which professors are appointed. They relate to—1, the stability of constructions; 2, stereotomie; 3, chemistry; 4, general physical science; 5, geology; 6, natural history; 7, hygiène; 8, history.

The whole establishment may also be considered as a branch of the Conservatoire des Arts et Métiers—a specialty for architecture. The pupils are admitted after examination to prove they are already grounded sufficiently in the subjects, and have aptitude for the studies of the institution. The course lasts three years, and the time of instruction is nine months in each year. The pupils live at home, and the hours of work last from half-past ten to half-past four each day, with an interval of an hour for lunch.

The establishment includes several workshops conducted by able instructors. Thus the teaching from the professor's chair directs and advances the labours of the pupil in the workshop, and the labours of the workshop enable the pupil to comprehend the lectures of the professor.

It is not possible to enter into all the details of the establishment. It is sufficient to state that, the course of instruction having been successfully followed for three years, the student, after a very strict examination, receives a diploma, which may be called a degree in architecture, and will, no doubt, obtain its place among the highest ranks of scientific honours.

But the architect, like the poet, *nascitur non fit;* and if it happens that few of the students become rivals of Bramante, Michael Angelo, or the cathedral architects of the mediæval period, still will these studies and this institution show no unsuccessful result if they only form a higher class of builders, and minds better able to comprehend and improve upon the ordinary plans and workings of the common-place and domestic constructions of the day. Every trade and profession has an artistic side or point of view. As in every trade there are artists so among those devoted more especially to art, many, alas! will be found whose will and hope have not been seconded by their power. The "Anch' Io son"* of Correggio, how many a delusive dream has it produced, from which the awaking is poverty, misery, and the regret of ambition thwarted, and a life misspent and a failure! Beautifully does M. Dupont de l'Eure express his view of the artistic life and feeling. Let me quote his words (November 1865) delivered at the opening of the institution:—

M. Dupont de l'Eure on what is an artist?

"An architect, gentlemen, is an artist. An artist—noble expression! by most how little understood! Still, it is as requisite to affix a signification to the word, and a condition to the man, amongst those who exercise and develop their ideas, as it is to acknowledge the position and duty of the man of science or of one engaged in industrial labours. I must endeavour to develop it.

"I have before me, in my mind's eye, one who has culled the facts of history—the past and the present; who has gained large knowledge of the experiences of the human race; who, by heaven-born gift and own personal effort, has arranged in order these facts and this experience, who classifies them on a system, and deduces therefrom their laws of action; that man is a philosopher—a savant.

"Another passes before me, who, with science for his weapon and experience as his guide, conquers, by methods known to himself alone, the facility of fabricating, bringing into general use, and cheapening any number of similar products; he is a producer—a workman—an *industriel.*

"All the world understands these two; but as regards the artist it is a different affair. He who conceives or adopts a thought, and expresses it beneath a form essentially and especially his peculiar; who calls, as it were, spirits from the vasty deep of his own unfathomable being (and they do come at his command), he is the artist, the lone man wandering ever amongst the lovely, to others undiscovered yet beautiful

* "Anch' Io son pittore," as he regarded at Bologna the "St. Cecilia" of Raphael.

prairies of his own creation, sustained by his own genius and living for his own work. And what *that* work?—A creation responding to his own ideal—that something to him and to his sympathisers—*the* thing of beauty and *the* joy for ever. Every idea laid hold of by the artist should develop itself so as to reach the senses of others; that is the chief end of art. To express and bring out ideas; to render them lucid, comprehensible, penetrative, attractive, and with power to seize hold of and retain the affection; such is the rôle, the profession, the work, the life of the artist.

"To follow the highest artistic profession is not in every one's power; yet each one may become for a time an artist, and for a particular purpose, object, and pursuit, according to his abilities. Lavoisier, Arago, Humboldt become artists when they clothe scientific discoveries in forms of language sensible, as it were, to the touch, comprehensible and attractive to the multitude—weaving, as by sorcery, the spell of words around the intellect and conjuring up to the imagination mazes of delight.

"The journalist, the advocate, the orator become artists whenever they excite to action and to life a multitude roused by eloquence to urge them on and on by cheers of approbation or hound them down with groans of dissent. For that speaker is an artist, whether Michael or Lucifer, who excites emotions, either false or true. But woe and misery to the false one!

"Again, the potter modelling a vase after his own idea, adding each secondary beauty in such a manner as to enhance the value and effect of the whole, having expended time, and thought, and knowledge on the production; who puts before the world the rare specimen of his craft by which the senses and the eyes are entranced, and which, not satisfied with mere sight, our very hands tremble with anxiety to embrace, fearful least we should not grasp the whole idea; he, too, is an artist.

"In like manner with the furniture-maker, carriage-builder, saddler, armourer, glassmaker, and all other trades. Whenever the producer exhibits any object that is not the mere product of a mechanical process, a something which bears the stamp of an individual mind and which acts on the feelings of the beholder by the medium of the senses, that is an art-treasure, and the maker an artist.

"And so, gentlemen in every occupation an artist may discover a field for his labours. He belongs not to any confined range. 'The world, the world is his.' Some professions and occupations seem especially the artist's home; yet even in these the professors too frequently are not

artists; while, on the other hand, the true artist may often be successfully sought in occupations remote from the ordinary notion of artistic life. I have thus endeavoured to define the nature of a man who executes a good work, and name him 'artist.' I use the word not in its professional sense, I apply it to the individual—to the man who creates a beauty in the shoe as to him who holds the pencil, the palette, or the chisel. 'He is an artist.' What means the phrase? It means that such a man does not necessarily follow the rules and common-places of his order; that when he undertakes a work he does not say, 'How does my 'compère make this?' but, 'How ought this to be made 'that it may be duly and rightly fashioned?'

"The world is continually peopled, for him, with virgin ideas; he is constrained to grasp their newness. Does he construct a house or build a coat, he consults how he may be able to cause either to accord with the peculiarities of the habitant or wearer; he does not utilise over and over again a certain form which conventional custom has already sanctioned; he seeks freshness and novelty. Whatever his work, be it small or large, he desires to fashion it as an express article, as a thing with an individuality. Such is the true criterion of the artist. Cursed is he if he be led astray from his true instincts. Ah! wretched man! if, contrary to his nature, he be drawn by circumstances of his position or compelled by destiny to enter upon the busy, bounded field of regulated industry. Powerful benefactress as she is, what can she do for him in the uninterrupted pathway of ever reproducing similarity? No production passes from his hands unless peculiarly appropriate to its distinct individual employment; not allowed to act thus, he nevertheless yields not; he takes a middle course, he becomes a semi-art producer. His models increase in number, and their reproduction costs increased expenditure. More business-like rivals contend with him in similar but inferior goods; these sell for less than would remunerate the actual but misplaced labour of our artist, and he dies a ruined and a soured man.

"Let us not, then, attempt in the same individual to fuse art with industry. Leave the artist what he is, but seek to utilise him. Let us preserve the artist; let us reward and bless him; let us elevate his thoughts and views; let us open to him the most extended horizons, that he may have power to expand to his soul's desire, for his work is, and will ever remain, the most engaging of those legitimate attachments that thought and labour procure to man."

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After this he proceeds:—"The true excellence of the "artist is not to be acquired by learning; technical instruc- "tion can be taught, the poetic ideal—not. But we can "instruct a man in the fixed methods of art-production; "that particular process by whose virtue the artist will be "enabled to utilise the personal gift which God, the all "Divine, has given him, by which he sees all things in such "light, and receives such impressions as are his, his only, "and therefore which he alone invents and produces to the "world. If a man be not nature's artist, no teaching can "make him one. The jewel must be there before it can be "polished; and the use of art teaching is to place a man "in such favourable conditions as to enable him to develop "all his faculties. The poet must know to read and write "and the rules of grammar; so the architect must be able "to draw, that he may be taught by successive stages to "mount to the higher currents of artistic thought, where the "views of the art enlarge at the same time as the spirit of the "man expands and the ability of expression is acquired."

Reply to opponents.

To those who have criticised the idea of forming this establishment, he replies:—"On every occasion of new ideas "arising, on the one side clear-sighted, on the other narrow- "minded, people express opinions. 'You go too far,' say "some. 'You are not sufficiently advanced,' say others. "May we not content ourselves, therefore, in believing "that we are in the right path? If teaching be requisite, "it cannot be too high or too complete. Each scholar will "take what he can turn to his own advantage. The strong "will become stronger, the weaker at least receive in part "the benefits offered to all." To the other party he adds: —"Instruction is a stimulant to the aptitudes of the true "artist, not a repression. How great the error, how grave "the fault, to believe that inspiration resides beneath the "calm of ignorance, beneath that dangerous quietude in "which reverie usurps the place of thought, since to replace "thought by reverie is to confound poison with nourish- "ment!" The conclusion of this most valuable address advises the students, "in no position is work more necessary "than the artist's; in none is it so difficult. All is lost "unless safety comes through belief in work. At the first "entrance on art all is agreeable, but if the student does "not bring a permanent habit of labour all goodness rapidly "becomes degraded. If a man hold not firmly to exertion "he remains for ever an infant—a uselessness for ever."

L'Ecole Municipale de Dessin.

Another adjunct to the Ecole des Beaux Arts et Métiers is L'Ecole Municipale de Dessin et de Sculpture à Paris;

director, M. Levasseur, Rue Volta, 37. It furnishes in the labours of its pupils exhibited abundant evidence of the value of the institution. The methods of teaching are excellent, and the results correspond. It has been established many years, and each year been attended with increased success. The drawing and casts in plaster and models in clay executed by the students are exceedingly satisfactory and real. Careful teaching and careful study are manifested. The schools are held on two evenings in the week. The direction of visitors to the Exhibition should be particularly addressed to the species of triumphal arch leading from the Rue de Flandres to the French Education Court—a work of considerable artistic merit in itself, and rendered more so by the plaster casts and statues which adorn and add to its effect. All these are the work of the students of this school of art, and very worthy of much attention.

The work is not merely well done in this establishment, but very rapidly. A man cannot be said to have acquired his proper knowledge unless he has it, as it were, at his fingers' ends ready to apply it at the moment required, and equal to any emergence he is called upon to supply. This is especially the case in Paris, where decorative art is so much needed, and so rapidly, for the various fêtes so frequent and so magnificent in their decorations and display.

The theatre too and the churches require, and provide support for, many artists thoroughly acquainted with decorative and scenic art; while every article of furniture, hangings, glass, jewellery, china, &c. demands for its production an amount of artistic skill and facility of execution from numerous hands not to be equalled in any other city in the world.

The rapidity of execution, as well as the completeness of the result, was tested at an entertainment given by M. Le Ministre de l'Instruction at his palais to the jurors of the Exhibition. Several of the students were invited to show their ability in clay modelling in one of the rooms prepared for the purpose, and in the course of a very short time—from one to two hours—had modelled in clay very excellent and very artistic productions from memory and from copy. In this short time frieze-cornices, and even busts, were executed by young men of 20 that would have been deemed artistic in England, but which here seem only the natural accomplishment required for the development of certain trades. Our own school of design at Kensington is following a similar course, and with an enormous success; but France, the

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nation, has been artistic for 300 years. Our own art-life in this sense, as a nation, was not born 30 years ago. To produce real art-study amongst the masses these must have been accustomed to live amongst art-works, as part of their daily existence. Art-works will be required in England whenever such advance has been made; and art-producers, similar to these students of the Ecole Municipale de Paris, be able to cultivate with success and profit the excellences which science and skill alone evolve, and which only high payment can remunerate and foster.

Other art schools.

The French nation are so convinced of the value of art, both morally and commercially, that in most of their large towns schools have been formed and buildings erected and supported at great expense both of individuals, the municipality, and the State. Several of these schools exhibit productions that may rival those of the great establishments of Paris, in which city there are many others of nearly equal importance to this of M. Levasseur. These schools are not conducted by mere drawing-masters, but are under the superintendence of elegant and accomplished artists.

Thus, M. Schrieber, of St. Quintin; M. Le Coq de Boisbaudran, Paris R. Ecole de Médicine; M. Lequien, Rue des Petits Hôtels, 19, Paris; M. Deuilly, of Metz: M. Gallard, Toulouse, &c. show very excellent designs.

Nor are females excluded from the cultivation of art, as is proved by the results from the establishments of Mdlle. de Morandan, sister to Mdlle. Rosa Bonheur, Rue Dupuytren, Paris; Mdlle. Levasseur, Paris; Mdlle. Jacquemart, Ecole de Gravure pour les Jeunes Filles à Mulhouse, and others.

The establishments at Turgot and Ivry seem to combine the commercial and artistic schools in one system of instruction, and very successfully. They are under the able direction of M. Pompée, and the works of the pupils have been deemed worthy of the highest mention by the jury of the class.

Ecole des Frères Chrétiens.

I must not omit to point out the very excellent drawings exhibited by the Ecole des Frères Chrétiens, 27, Rue Oudinot, explained as was the manner of teaching by their very able, intelligent, and evidently most amiable and excellent instructor. I refer to them with regret to think how few schools of the working class in this country could produce such results, or show such careful teaching. I know, too, that the schools are so well taught in other respects that few can produce more lively and intelligent pupils in every branch of ordinary education.

Ecole Centrale Lyonnaise.

The Ecole Centrale Lyonnaise seems to have originated as another offshoot, or in consequence of the success of the

Centrale Ecole des Arts et Métiers of Paris, in the same way as the provincial schools of art in England have their paternity in the school of art at Kensington.

An identity of views seems to have actuated the founders of both institutions.

Effects of free trade on education.

The necessity for this establishment is thus asserted, "L'industrie (I use this expressive word, though not English), "makes vast strides daily; its methods are continually pro- "gressing by means of incessant changes; that progress may "really be made prudence and intelligence are requisite— "the prudence of experience, the intelligence of scientific "applications."

There is now great contention and rivalry among nations, and victory will belong to those who possess most intelligence, knowledge, and energy.

"L'industrie," formerly unaffected by foreign rivalry, competed only with producers of its own nation, and the contention was comparatively small. But now that free trade has opened to the world one grand universal market, the contest has become, in truth, a severe reality, and it demands the utmost powers of the ablest man to gain the prize.

It is not only l'Industrie that has advanced; every idea has made progress. Protection has crumbled into night, and the sun of free trade is already resplendent on the horizon; a new era manifests itself, and an immense field is offered to the energy of new generations. Under this novel régime l'industrie must put forth renewed efforts to maintain its place, and support that immense competition which day by day is becoming more and more established. Men of sense, instructive, intelligent, and energetic, must be found or created, and the rising generation must be provided with the means of obtaining an education, say educations, of a special order, adapted to the new condition of circumstances in which it will be placed.

To supply such needs these central schools of art have been created: uniting practice to science, they fulfil at once the position of the school and the apprenticeship. In the school the theory is developed, in the workshop the practice, and in the visits to the different factories the experience of manufacturing life is acquired.

Of course they are not intended for the mere labourer, but for the upper class superintendent, the foreman, eventually to become the partner in the firm, or the master engineer, in its highest sense. The aim is to produce the mean between the savant who devises the principles, and the workman capable of comprehending and applying the discoveries of science.

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This central school of Lyons seems to have adopted much the same course as that of Paris. Great stress is laid upon drawing freely and quickly, as well as accurately, from designs, and from the machine itself, and from memory, any object, however complicated, placed before the eye.

The pupils visit various factories in Lyons and the neighbourhood, and in the summer make excursions to observe any celebrated works in course of completion, as bridges, buildings, tunnelings, &c.

Amongst the excellent features of the establishment must be named the collection of models of machinery made by the advanced pupils, which is formed with a double intention—1st, as a collection of models for the use of the school; 2nd, to exhibit to the pupils the manner in which works of the factory should be executed, and the defects of those at present in use. It also teaches them manual labour. The models exhibited are very interesting. With all their labours, however, the directors do not pretend to make perfect men: "They continually and forcibly remind their pupils that "after quitting the school they have still a long apprentice-"ship to serve, that of experience and actual labour. All "commencements are difficult and laborious; but by utilising "the instruction they have received the future of the pupils "is in their own power. It is for them to make known the "knowledge and science they possess and to bring into "favour more and more the name of the school, which has "already shown its title by success and has bestowed upon "them the means of gaining an honourable position in "society."

Ecole Théorique et Pratique de Tissage de Mulhouse.

The Ecole Théorique et Pratique de Tissage Mécanique de Mulhouse is intended to form managers and overlookers for manufactories of weaving, and gives instruction at the same time both in the theory and practice of mechanical weaving.

It owes its origin to the introduction of free trade principles. The rivalry of other nations in their own market has made France comprehend that to maintain her position she must be forward to use every advantage, and among the chief is to be reckoned the bringing up of skilled upper class artisans occupying the position of intelligent and well instructed foremen. To train such men is the object of this institution. Before entrance they are subjected to examination, and must exhibit considerable general knowledge and information. The students most probably belong to the lower middle class. The price paid for instruction is 600f. (24*l.*) per annum.

The school is well provided with all the apparatus necessary for its objects. It possesses steam power and workshops, and a complete range of machinery for weaving has just been added. These machines are constructed on every approved form, with the latest improvements, either English or French, and for every sort of weaving work; so that the student may be thoroughly instructed in all the best and most modern methods of fabrication.

The principles of action of each machine are thoroughly inculcated both in theory and by practice.

In the first years the pupil learns how to decompose and analyse all the different forms of stuffs, ordinary velvets, gauzes, &c., and studies principally the patterns suited to the local industry. The course of study finishes by lessons in drawing of patterns, of machines, of buildings for factories, of the best plans and construction; and in accounts, with the principles of commercial arithmetic and the chances of commercial success.

The whole of the student's acquirements are attested by examinations, to which a certificate of capacity follows if successful progress has been made.

Inventors are invited to send their inventions to the school, that the newest improvements may be seen and known.

There is also a school of spinning on the same model, and with the same advantages for learning the principles of the art—or, rather, art-trade.

Le Creusot, the works at.

The establishment of Le Creusot, occupying a vast territory, has formed an immense manufactory of iron and coal, situated between Autun and Chalon-sur-Saone. It was founded in 1769. It may be interesting to the English reader to know that one of the earliest engines of Watt was erected on these works; its old cylinder, bearing the date 1782, is preserved in one of the courts. The description of the situation of the works reminds of the country around Wolverhampton or Stoke-on-Trent; but the company possesses a much more extensive range than is found in either of these places, occupying 24 square leagues.

From the period of its establishment, in 1769, it suffered various vicissitudes and changes of direction and owners, and produced a great number of the larger works manufactured in iron in France. During the wars at the commencement of the century it was much employed for military service. Cannons, balls, and bombs were made there. Nor were its labours less onerous or successful for the more useful arts of peace, as the original gaspipes of Paris, the cupola of the Halle aux Blés, and the pumping machinery of Marly, bear witness. An English firm held possession from 1826 to 1834,

and it fell into the hands of M. Schneider in 1836, the gentleman elected by the Emperor to sustain the very high and very important position of President of the Senate.

Since his accession the name of Creusot is to be found on very many of the largest iron-wrought erections of France and elsewhere, the bridge of Brest, that of Freiburg, the large steam-boats of the Rhone, and rails for many railroads; in fact, every production of a very first-class iron working establishment.

The number of workmen employed reaches 10,000. It is a curious fact that the hands equal in number the steam power, being the same as the number of horses. The establishment is exceedingly well conducted, and the greatest attention is paid, in every respect, to the wants and comforts of the workmen and their families. Houses are built for them and churches and schools maintained. It is to the latter that our attention must be directed. No boy is allowed to enter the workshops till fourteen years of age. No females are employed in any way or of any age. It is to be regretted that attempts to introduce into the district proper industrial work for women have not hitherto proved successful.

The schools.

The influence of the works has been such as to improve most materially the population of the country round about; and the directors attribute this progress chiefly to the establishment of their schools, in which a high class of education has been afforded to the scholars with very great success.

Before the present establishment commenced its wise and liberal labours the population are described as neither strong in mind or body; but now better nourishment and dwellings have improved their faculties, and better schooling called out their intelligence, so that the present generation much excels its predecessors, and will be succeeded by a higher class still, when those now on its school benches shall rise up to occupy their places.

One great cause of this success is that the wages of the men rise in proportion to their power of executing their work, and the company arrange it so that the best fed and the best taught obtain the highest salaries, thus offering a decided prize for good conduct, good education, and good rearing. The number of children under fifteen years of age amounts to a third of the population.

No praise would be exaggerated which gives to Creusot the merit its schools deserve. Their expense is provided for by the firm, with the greatest liberality: they build the rooms, they provide the teachers, they direct the morals and the course of studies.

The director of the schools received his education at the University. It is unnecessary to speak of his complete aptitude for the conduct of such an establishment. There can be no doubt he has been well selected and is especially able.

The schools furnish the skilled and intelligent workman to the factory, whence they draw their support; and both the schools and the factory gain much advantage from the interchange of mutual civilities. The rivalry between them is confined as to which shall most aid the other.

There are two principal schools, and a number of smaller ones connected with them; 4,065 children—2,259 boys and 1,845 girls—attend them; and the very youngest are received, in addition, into dame schools—"garderies."

There are 12 professeurs (teachers) for the boys and 11 Sœurs de St. Joseph for the girls. Under the name of primary instruction is included a much more extensive programme. The school has nine classes. The inferior ones receive only the mere elements of knowledge; in the upper ones the powers of the children are so enlarged that in the highest class they attain a very extended acquaintance with literature as well as science, exercises in style, history, cosmography, arithmetic, algebra, geometry (descriptive), mechanical physics, chemistry, and the elements of sculpture and drawing.

Here, then, are found all the elements of a real special education, which has this great advantage—it is entirely based on the applicability to certain useful requirements, and gives to these an immediate purpose.

The factory keeps lists, on which are inserted the names of those of their people who manifest a capability of becoming good clerks, of workmen who comprehend at a glance the drawings of a machine to be constructed, of foremen able to direct a Bunsen pile and to whom the phenomena of chemistry may be familiar. The director has also established courses of lessons in bookkeeping, drawing, physiology, and chemistry. Though it is true that these studies have enabled some few of their people to apply themselves to other spheres of labour than that of the factory work, yet the firm itself has benefited much by the number of excellent workmen and foremen who, having manifested special aptitudes for various branches of their own industries in school life, have afterwards entered into their employ.

Mettray.

The establishment at Mettray* is so well known by various publications in England that it is only necessary to point out that there is in the Exhibition building a model of the build-

* A report on these schools was made in 1845, I believe by a Mr. Hills.

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ings of that institution and several articles manufactured by its *détenus.* Mettray may be considered as the parent of all similar institutions for the reception of young people who have subjected themselves to penal law by theft, violence, or vagabondage. From the example set at Mettray industrial penal schools had their origin in most countries, as Redhill, &c. among ourselves. It was a grand invention at its commencement, and M. Demetz is worthy of all honour for the establishing of an institution on such enlightened principles as commend themselves at once to the approbation of the religious, the philanthropic, and the philosophic. It was he who first imagined that untamed youth of headstrong and malevolent passions unrestrained might be better brought into order, reason, and propriety by mild and gentle operations rather than by the exercise of mere brute force. He has also possessed, what is of even more influence and utility, the merit of establishing an institution conducted on the highest moral and civilising principles, which has been a success from the beginning, and which now for more than 30 years has continued to be most ably worked, without degenerating in any degree; but, indeed, with every year increased and increasing usefulness. One of its chief charms to an English mind is the fact that its great achievements have been obtained in the soundest and severest manner, by simply adhering to the plan of carrying out the highest scheme of usefulness with calm, deliberate judgment, without enthusiasm, or fanaticism, or excitement, simply from a sense of religious duty. It is impossible to point out with too high a sense of admiration the labours—personal labours — of this most excellent gentleman. The member of a learned profession, and very high in the ranks of that profession, he has for 30 years devoted himself unceasingly to the interests of the establishment; he has resided constantly amongst its dwellings, and his absences have been only when he felt it a duty to seek and to save the lost sheep of his fold or to bring others into its enclosure.

M. Demetz.

Mettray was founded principally to remove criminal male children under 16 years of age from the public prisons, and subject them to an ameliorated and reforming treatment. Its principles of action were those of the Gospel—"Do unto "your brother as you would be done unto." "Pity the "unfortunate and abandoned—restore them to reason and to "society. They are ignorant, teach them; they are vicious, "reform them; they are idle, give them a pleasure in work; "they love evil, give them a power of enjoying good."

Mettray was established in 1838, about six miles from Tours, by M. Demetz, in conjunction with Le Vicomte

Bretignières de Courteilles. These promoters considered that agricultural labour would afford the best employment for the young *détenus* (sentenced criminals). His idea is expressed by himself—"to improve the land by man, and man by the "land;" and another of his maxims has become the legend of the establishment, "*Loyauté passe tout*" (Good faith is the key of society). We regret not to be able to enter into the plans by which success has been obtained. The establishment has become the type and model of all similar institutions in France.

Mettray has received more than 3,000 *détenus*. Of these, 2,245 are known to be dwelling with propriety, engaged in various trades and in naval and military service; three have received the Legion of Honour; the rest seem to be still in the colony. I suppose some may be (though it is not stated in the report) considered as relapses or dead. Touching stories are told of the inmates; but the best proof of the value of the institution is the sense in which it is held by the people of France. "All the departments every year vote a "sum for its support."

Statues have been erected among peoples to men with less claim to honourable recognition than M. Demetz; and, perhaps, in time to come, the tardy cities of enlightened Europe will raise in their public places monuments to his honour, as Genoa, after 300 years of neglect, has lately erected a trophy to Columbus's fame.

A peculiar establishment has been added to Mettray since 1850.

The law of France authorises parents to shut up for a limited period, as a means of correction, any child against whom they have grave subject of complaint. This seems founded on the old *lettre de cachet*. It seems that the young gentlemen of that country revolt not unfrequently against the strict discipline of the Lycées; they are returned on their parents' hands; no other Lycée will receive them. "I shall "expel you," says the director. "Bravo!" says the boy; "*vacances perpetuelles!*—nothing but holidays!" And what on earth are his parents to do with such a lively specimen of precociously vicious humanity? In England he does as he likes; in France there is the prison. Now, the thought struck M. Demetz that he would found an institution to receive such peccant individuals, where they might, according to law and the will of the parents, be detained, if under 16, for a month; if under 21, for six months. They are subject to almost penal discipline, which appears to be very strict, and includes solitary confinement. Once there, he has no longer a name. Two brothers have been in the

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establishment at one time without knowing it. He speaks only to the chaplain or the director: with his teacher he takes daily walks; he may write to his family. By aid of solitude and continual talking, the young recluse, at first obstinate, at length comes round; he repents; after some weeks the régime is softened, and ultimately he is restored to his friends, an altered, and perchance a sadder, man.

It is possible to express doubts as to the desirability of this penal enactment and this system of solitary confinement for crimes, which, after all, may only amount to what in England would be considered mere boyish petulance. However, it appears to have its admirers in France, to agree with their system of child government, and to be entirely in accordance with the letter and spirit of their laws. In England we should be jealous of authority thus placed in the parents' hands. What use might a step-father make of such power? What use a vicious father to get his son out of the way? We see one father has already had two sons in the establishment at the same time. Were the sons alone to blame? What was the father's conduct? How had he brought up those youths? These and other questions will arise to the English mind. It is useless to push such inquiries further. It is not likely that a "maison paternelle" will ever be founded in Britain. M. Demetz, however, deserves the highest praise for devising a plan of humanity suited to the laws and feelings of his own nation, so different to ours.

Société de Secours aux Blessés Militaires.

Among the objects in the Exhibition that will be regarded with greatest interest, not on account of its artistic merits or the beauty and excellence of its mechanisms (which are great), nor of our sympathy with its origin, but for itself, for its high yet shudder-causing utility, is the block of buildings, distinguished by a flag with red cross on a white ground, devoted to the Société de Secours aux Blessés Militaires.

This admirable institution received the sanction of the Emperor on June 23, 1866. Its object is to assist in providing comforts for the sick and wounded on the field of battle, in the ambulances, and in the hospitals. It is purely voluntary and supported by subscriptions, donations, and legacies. In time of peace these are funded so as to form a bank on which to draw if any lamentable occasion should arise to demand the exercise of its kindly offices.

Though the head department is in Paris, the society is extending itself through the provinces, and promises to be well supported by a people to whom the horrors of war are not personally unknown, and among whom is no family but may some day or other in its members demand and need its benevolent assistance.

The principles on which it is founded are recognized by every great State of Europe, with one exception; and similar societies are in action.

The society has provided an exhibition of intense interest, including ambulances of improved construction, surgical instruments, medicine chests, hospital beds, tents; in fact every conceivable necessity that may be required for the wounded soldier. One of these, a paper bag of water, which cools by evaporation, may be very valuable, and is certainly curious. But the mere mechanical is not the only means by which its members hope to be useful if, unhappily, wars should arise. They are busy in organising a society of members who should accompany the armies to the field and act, in conjunction with the authorities, in their pious and evangelical work. At present they are obliged to confine themselves to the members of a religious society, the brotherhood of St. Jean de Dieu, a corporation who pass their lives in attendance on lunatics, old men, and sick children; and whose devotion to their work is above all praise.

It is believed, should the occasion arrive, that they will be joined by large numbers of laity, whose religious zeal or generous impulses may lead them to give personal aid to suffering humanity, and who will not scruple, from sense of religion and duty, to hazard the dangers of the battle-field and its almost still more terrible accompaniments. There is also a yet more ultimate and secret intention of the society: they hope to be the means of so turning men's thoughts to the horrors of war as to make wars less possible on earth, and render to all nations the truth of the Gospel proclamation, "On earth peace, good-will toward men."

## Prussia.

Association of working men at Berlin.

The association of working men at Berlin is worthy a notice. It is an establishment similar to our own mechanics' institutions. In 1864 the society built a hall on a piece of land bought for 24,000 thalers (3,500*l*), and the establishment cost 44,000 thalers (6,400*l*.) additional. It is the first establishment in Germany destined exclusively to the instruction of the working class. There are 3,000 members, who must be 17 years, at least, of age. They pay three silbergroschen (10*d*. a month). Of the members nine-tenths belong to the working class. By the apprentice usages of the country certain years of the apprenticeship are passed in travelling. This institution is open to these wanderers; they equal 10,000 per annum; and it is considered that 60,000 workmen have used the institution during the last seven

years, the society having been really formed in 1843, but reconstructed in 1859. The arrangements seem very complete, and include lectures on all subjects of science, with soirées, concerts, and balls. A large hall and garden receive on these occasions 2,000 guests, among whom are women and children. There is a library of 3,500 volumes, much used by the members, especially those works which relate to commerce and trade.

## Saxony.

The following exposition of the state of education in Saxony will not be without interest to English educators, more especially when the success attending it may most undeniably be recorded in the following terms:—"We dare, "without presumption, and in perfect harmony with truth, "affirm that our institutions in the main have entirely "answered all reasonable expectations. That not only have "the arts of reading and writing become diffused amongst "the whole nation, but a very elevated state of religious, "moral, and actual instruction pervades all ranks of the "population."

In Saxony the origin of elementary education of the poor dates from the Reformation. Still, it was only in 1835 that it commenced its present form. Before that period no system had been developed and spread through the kingdom.

Under the title of schools of elementary instruction is included all schools in which the children obliged to attend them receive, for eight consecutive years (from six to 14 years of age), a systematic education, which finishes at their confirmation.

All these schools in their principles set themselves the same task. To them is confided the first methodical development of the human faculties, by means of instruction and teaching; and they only fulfil their duty when they have established in their scholars all the elements of knowledge and science, and brought out those capacities which constitute as well the education of man in general as of each one's particular vocation.

In addition to the ordinary instruction of English working-class schools, the elements of universal and natural history and geography are introduced.

A distinction, important to observe, is made in the instruction given in mere village schools and that afforded by the schools of large towns; for these latter a higher class of study is required, extending to literature (general), drawing, and geometry.

In the kingdom of Saxony the smallest village, even the most remote cottage, is included in a school district.

The attendance at school is obligatory on every child from six to 14 years of age; and if the children neglect to go to school, the State punishes the parent or the guardian (next of kin?) by a fine or even short imprisonment.

Education compulsory.

"The State," says the report, has a perfect right to require an entire obedience to this law, because it will not be able to maintain the position for which it was itself established (viz., the good order of the people), if its citizens have not received a certain amount of knowledge and education.

Reasons why the State should insist on education.

So fully convinced of this view are the people of Saxony that there is no difficulty in (I might even say necessity for) enforcing this law. The people rather demand its requirements; and the most satisfactory proof of the goodness of the schools and of the wisdom of severity in carrying out the law, is derived from the fact of the rarity of any necessity for bringing its provisions into action.

The present generation, having itself enjoyed the fruits of this good instruction, has by degrees acquired a conviction that no greater benefit can be conferred upon their children than faithfully and conscientiously to provide for their education; and, far from abstracting from them the obligatory attendance, the poorest parents often pay for extra instruction.

All parents, rich and poor, are under the same law of education: but the richer classes send their children to schools of superior instruction, or else have them taught at home by capable teachers, who are certificated.

Every household contributes its portion to the support of the public schools of the district. The State pays nothing, except in certain very poverty-stricken places.

The contribution of each child is in simple schools, $2\frac{1}{2}$ sous a week; in the superior schools the fee rises to 5f. 10 sous a month.

The salary of the teachers is fixed and variable; the lowest is not under $562\frac{1}{2}$f. (say 25*l.*), the highest, 1,350f. (say 54*l.*).

This is the sum required by the State; but, of course, this lowest figure is by no means the rule.

What has contributed most to educational advancement in Saxony is that the population are almost all of the same religion; there being only 60,000 Catholics in a population of 2,343,994.

This population includes 400,229 children of school age—viz., 199,446 boys, 200,783 girls.

Schools are opened on Sundays for poor people's children, for boys at work and apprentices; I conclude above 14 years of age.

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It is not necessary to enter upon the teaching of the higher order of schools and colleges.

Ecoles Réales.

The Ecoles Réales form the commercial and mechanical branch of instruction for those intended for commercial or engineering life, and the college for those of professions. In the former, mathematical science; in the latter, Greek and Latin, form the bases of instruction, which seems to extend over a period of nine years. One peculiarity of Saxon education is to be found in its gymnastic establishments, for which masters are trained who pass an examination.

Gymnastics.

The Saxon Government is the first in Germany that by legal enactment has regulated the education of masters in gymnastics and the extent to which this branch should be carried in elementary schools. Teachers of gymnastics are formed in the gymnase at Dresden.

The Saxon educational portion of the Exhibition is well worth attention. A very excellent and large model of the gymnastic school at Dresden is one of its most prominent exhibits. The number and variety of gymnastic apparatus are very great and complete.

Much of the educational apparatus exhibited is very extraordinary on account of its cheapness. Thus, No. 82 is a complete apparatus for teaching physical science, at a price of 26f. 25c., or about a guinea. It contains 29 objects.

The applications for teaching of M. Glootz, of Dresden, also are very good; and for those who desire to know how Greek and Latin are taught in Saxony, and with what success, their curiosity may be satisfied with compositions in both languages, from Zwickau, Grimma, and Meissen.

## Würtemberg.

Schools of Art.

The exhibition, or rather exhibitions, made by Würtemberg in regard to education, especially as connected with the fine and industrial arts, are among the most excellent in the building. In galerie 11 are shown the most exquisite models, in plaster and wood, of architecture, of carpentry, and all that comes under the name of artistic industry. They will amply reward the most attentive consideration of every one who believes that the progress of manufacture depends much upon art knowledge in the workman. Not only are the forms themselves excellent, but the execution of each object is all that can be desired; and there is no other country which pretends to anything like their completeness and success. The second portion is equally worthy of observation, consisting of exhibits of the use made of this material for instruction, as shown in the works of the students of the various communal schools of art in the kingdom. No less than 45 of these

schools have sent specimens of the works of their students, and many of them are most deserving of praise for the complete artistic feeling which pervades the character of the drawings. These are hung in the gallery of the annexe in the park, behind the Bavarian picture gallery. They well repay a visit, and explain whence it comes that art in so many ways manifests itself in all the very interesting productions of that small but enlightened State.

The development of these communal schools for workmen in Würtemberg demands consideration. In schools of technical art not only should the student be called upon to acquire the theory, but, if possible, what is even more important, each young artisan should have opened out to him, in addition to the elementary instruction given in the primary schools, those methods by which he can appropriate to himself the sum of his scientific studies; of that knowledge, both scientific and technical, so necessary—so indispensable—in an age when rivalries of trade and refined public taste make such large demands on improved production.

Origin of.

In Würtemberg the whole people seem to have come to one opinion on this matter, and that from a very early date. In 1818 "a series of lectures on art and mechanical science" was added to the programme of the then ordinary Sunday schools. These were enforced and created with the object of preserving the knowledge acquired previously in the day schools of the people, and establishing in the Sunday schools of large towns special classes for apprentices, where drawing should be taught. These attempts, however, seem to have produced but small results; they were isolated, and wanting in unity. But in 1848 the Council Royal of Science, and that for Commerce and Industry, established a commission, in order to advance "des écoles professionnelles"—technical or trade schools. This commission appears to have worked, not authoritatively, but persuasively, and perhaps chiefly by the power it had of offering to the various communes (say parishes) a subvention from the State as large as the half of their expenses, on condition that the school should be organized with the object of carrying out the scheme adopted by the Royal commission.

Two fundamental principles were required by the commission—1, that the schools should be free to all; 2, that a certain part of the expenses should be paid by the commune, because, as the report says, it is incontestably established that whatever a man gives something for he esteems more highly than what he gets for nothing; and the result has borne out the force of this conclusion.

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The commission was amply aided by the Government and by the Chambers of Parliament, and large funds were supplied for all the necessities of the service. Models, drawings, drawing and plastic materials, were by no means grudgingly provided. Normal schools were created for the instruction of teachers, of which that at Stuttgart was the chief; and at the present day there exist working class schools in numerous parishes where, on Sundays and evenings, courses of lectures on industry and trade are given, and also where drawing schools are open daily, either with or without the assistance of the teacher. At Stuttgart, Ulm, Reutlingen, Heilbronn, four schools exist, with a total of 2,500 pupils, of whom 130 are females, in two schools at Stuttgart and Reutlingen.

These schools are styled "Ecoles Ouvrières Communales." Other towns possess like institutions. Schools that seem not to belong to so high a class are scattered over the whole country. The total of schools is given at 101; of pupils at 8,000.

Such is the provision made in this small kingdom for the instruction of its people in art. It is to this system it owes its very high rank among the artistic nations of Europe, and which gives its manufactures an impulse of great force, creating an exceptional demand for its products. We may believe, also, that the steady, sober, quiet, enjoyable, sensible life of its people has received from this source an addition of real happiness of much more value than words or wealth express; and amidst the conflicts of the period, amidst all the late political divisions, excitements, and disturbances of Germany, the population of Würtemberg has been eminent among those people who have exhibited most quiet, most satisfaction, and the greatest absence from internal and domestic strife. Würtemberg is reported to be mother and chief fosterer of all the educational progress of Germany.

## Bavaria.

Academy of Nuremberg.

The school of art at Nuremberg was founded under the name of "The Academy of Nuremberg, in 1662." In 1852 M. Kreling, of Munich, was appointed director.

The working principles of the institute are based on the capacity of the students. A young man of talent, who devotes himself to the career of an artist, obtains here the means of making himself acquainted with all the branches of the fine arts. The less endowed student, who prefers attaching himself to a special branch of the arts of industry or architecture, receives an instruction solid and conformable to his future plans.

The school joins the science to the practice of art, and has furnished many beautiful works to various churches and towns. The pulpit of St. Sebald may be mentioned as one; also bronzes, altars, candelabra, and crucifixes. It applies its resources also to painting on glass, and, in fact, to every species of artistic construction. Many proofs of its success will be found in the Exhibition.

The terms of admission to the school are:—*a.* The candidate must be 16 years of age; *b.* must have attended with successful results a preparatory school of drawing and modelling; *c*, must give actual proof of talent in these arts; *d.* and submit to a satisfactory examination. He is then admitted for six months, and, finally, as a pupil of the school.

There are altogether 12 professors and masters. The buildings seem well adapted for the purpose; and, among other requisites, include a bronze foundry and a large art library. The school is supported by the State. The commune (town) repairs the buildings; and scholarships have been founded by the city of Nuremberg and by private legacies.

## Austria.

The art-institutions of Austria are similar to those of Germany in general. The specimens from their school of weaving at Brunn seem peculiarly excellent. They exhibit some magnificent collections of models in wood, very cheap; also some large drawings for a whole class to copy are good. It would of course be impossible to hope for a demand in England for these materials, as the expense of carriage would depreciate their value as to cheapness. The models of M. Bauer, of Pick, are very good; also those of M. Theodore Böhm, of Reichenberg. The Imperial School at Vienna (52 and 53) shows some plaster modelling which may be usefully compared with that of Lambeth School of Art.

The establishments included in class 89 (57, 58, 59, and 60) show the progress of art in Viennese schools, and have received high commendation. They are supported by the Chamber of Commerce at Vienna.

In class 90 (4), a museum for schools has high merit; also some small models of articles used in teaching for infant schools; also some models in plaster of insects (foraminifers), of M. Charles Gerold, of Vienna; also models of natural history, by M. Fric.

## Italy.

It is gratifying to observe that the renewed Kingdom of Italy, amongst other progresses, rapidly advances in the education of its people. Normal schools and schools of art

and drawing have been established, and the documents of the Minister of Education at Florence are highly valuable for the information they afford. The Institute Manin at Venice deserves very high mention, class 89 (49); also the Technique Institution of Florence (45). There is also a society (Association Italienne pour l'Education du Peuple) answering to our great societies. Indeed, the progress of education among the poor in Italy seems to excite by its success the jealousy of the upper classes, who have united to procure for their own children the advantages afforded to the classes below them, and have formed a society at Milan for that purpose.

## Egypt.

From Egypt there are calendars, Arab and Turkish; books for schools, and also works executed by the scholars, interesting for themselves; but few of our visitors will be able to decipher their contents. It is a mistake to suppose that Mohammedans are uninstructed. All read and write; all repeat the Koran; and it is a condition of their religion, I hear, that every Mohammedan writes out during his life a copy of that book of the Prophet.

## Spain.

The following sketch of the state of public instruction in Spain will be interesting, as it concerns a people whose institutions are so little known in England. It is from the pen of M. Carderera, the Spanish juror, to whose kindness I am much indebted. He is an inspector-general of schools, and chevalier of several orders.

The instruction of the people (instruction *primaire*) is conducted in infant schools, elementary schools, superior schools, and adult schools. Any certificated person may keep a school. There is a school for boys in every village, and one for girls in every village of 500 persons; and for every 2,000 persons additional there is another school both for boys and girls. The teachers are well recompensed.

For the secondary or higher instruction there is an institute in each province maintained by the province, also private schools. The instruction is given in two branches, classical and commercial, industrial or agricultural. The highest class of instruction includes philosophy, literature, sciences, law, theology, and medicine. There are ten schools in the university for these subjects. In the University of Madrid all the branches are studied; in the universities of other towns, only three or four.

The second course comprehends architecture, the fine arts, mines, engineering (*pons et chaussées*), agriculture. The chief schools are at Madrid.

There are also normal schools for the formation of teachers.

The following are the statistics:—

| | |
|---|---|
| Public boys' schools | 13,238 |
| Free boys' schools | 1,643 |
| Public girls' schools | 6,117 |
| Free girls' schools | 1,770 |
| Mixed schools | 2,094 |
| Infant schools | 573 |
| Adult schools | 1,665 |
| Total | 27,100 |

The number of pupils is, in

| | |
|---|---|
| Public schools, boys | 763,022 |
| Private schools, boys | 87,869 |
| Public schools, girls | 424,112 |
| Private schools, girls | 94,074 |
| Total | 1,369,077 |

The expenses of these schools are thus stated:—

| | |
|---|---|
| At the charge of the communes (parishes) | 17,178,359 f. |
| At the charge of the provinces | 1,547,245 f. |
| At the charge of the State | 245,916 f. |
| Endowments | 409,620 f. |
| Payments of scholars | 2,350,905 f. |
| Total | 21,732,045 f. |

Education of the working-class schools in Spain is conducted, as respects teaching, on the model of the British and Foreign School Society, and their infant schools on that of the Home and Colonial.

I took great pains in going through a series of their Bible pictures for infant schools, and there was nothing that in any way would offend the most Protestant eye. They were, in fact, exactly of the same character as our own.

The schools are entirely (as I understood) Catholic, none other being (as may well be conceived) sanctioned.

The above statements will prove that education is in a much more advanced state in Spain than is commonly believed in England.*

* Having visited schools in Madrid, Seville, and Valentia, I am able to state from personal observation that the schools of the country equal the average of our own. There are few infant schools here as good as that at Valentia.

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## Great Britain and Ireland.

The exhibits of class 90, in the British department, cannot be said to have equalled either the dignity of the nation or the importance of the subject. I speak of the *private* exhibits —those of the Kensington Museum are too well known and too conspicuous to need any comment in this place. Nor would it afford any information to detail the arrangements of any of our educational establishments. The reports of our bluebooks are sufficient. The religious societies and the Pure Literature Society show considerable collections of books. These afford, however, only scanty specimens of works for which the demand, on account as well of religion as of language, cannot obtain a great circulation in France. Our educational booksellers do not seem to have considered the advantage of exhibiting equal to the cost, and have not made, consequently, a large show. No novelty is exposed; there is, consequently, nothing particular to observe.

South Kensington School of Art.

The drawings and modellings of South Kensington—not numerous in comparison to what could have been shown—attract attention; and the methods of teaching in that establishment have been highly appreciated by the jury of foreign artists. They consider, however, that the figure drawing is not equal to the rest, and should be more cultivated. It has been explained to them that there are difficulties in this branch in consequence of the general distaste of our people for figure subjects. A gold medal has been awarded to the establishment, notwithstanding this defect.

Lambeth School of Art.

The exhibition of the Lambeth School of Art appears to be very good; and there is no doubt that had a large selection from the works executed by the students of all our schools of art been exhibited, as in the Würtemberg division, we should have obtained a higher place in the opinion of our neighbours. We are, however, justified in stating that immense progress has been made in the last ten years.

British catalogue.

I must refer to the English catalogue of the British section, price 10*d*. in four languages. Its price is extraordinary. Among other desiderata in education is a book on nomenclature. This publication goes a long way towards furnishing this want; relating as it does to all trades and manufactures, it gives the name of most objects of art and science, and that in the four languages. It may be considered a very good educational book, and in that light its usefulness will extend much beyond the year of the Exhibition. It might be introduced most profitably especially into all commercial and scientific schools, not to omit those of the highest class also. Perhaps a compendium might better answer the purpose.

M. Cronmire (class 89, No. 1) exhibits some very excellent as well as cheap mathematical instruments. The collection of M. Damon (class 89, No. 3) deserves attentive consideration; so also does M. Wright's (16).

M. Stanford's maps have obtained a medal.

The Home and Colonial Society also exhibits its books and models.

### Canada.

The cases exhibited by Canada are very interesting, containing documents concerning the educational condition of that very important country, which appears to be making great progress.

### Sandwich Isles.

Among not the least interesting of the Government exhibitions is that of the Sandwich Isles. The advancement made by that people in schools, literature, and printing is really marvellous. The character of the Queen seems to have impressed itself on the people and their institutions; and, if there be no jewelled crown and sceptre to manifest its regal wealth, there is that exhibited of much more importance to the well-being and happiness of the nation, the results of an extensive and real religious, moral, and intellectual instruction. The visitor will observe the Bible, and other religious books, and works on arts and science, produced in a tongue not indeed "understanded" of his own people, but equally efficacious for good to that small and isolated nation. Though he may not be able to read the language, yet he will perceive its significancy; he will mark the progress of civilization, not, as of old, by the gallows, but by the Divine word, and believe in the presence of a life and love inspired by Gospel truth and moral virtue.

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Conclusion.

I have, unfortunately, not been able to include reports of Prussia or Belgium in this notice, a matter to me of much regret, softened, however, by knowing that Belgium adopts a system similar to that of France, and Prussia to that of the rest of Germany, so that *mutatis mutandis*, what is spoken of the one country may be equally applied to the other.

To any reader of these pages it will have occurred that all nations desire, as I started by affirming, progress; that most nations have devoted very large funds to education, both the higher and the lower and the artistic; that they have all obtained, for purposes of education, the assistance of the ablest men, whom each Government has not only created, but also provided with ample emoluments, and rewarded with noble

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honours. Such is the report as respects foreign nations. None are ignorant as to what extent such observations apply to ourselves. But if there be any who imagine that England can remain behind, can fold its arms quietly and look on without taking steps to emulate the progress of other people, and yet retain a high position at the head of nations, such are entirely mistaken. The present Exhibition proves the fact. Once the chiefs, we are now scarce the equals of our rivals. To their superior common class education intelligent foreigners attribute this result, as well as to the pains taken in forming overlookers and foremen; and, in answer to objections that have been made, each Continental State unites in one common voice to declare that moral progress and virtue have gone hand in hand with intellectual, artistic, and scientific advancement.

M. Dufresne.

In regard to the whole report on the class, I cannot improve upon the language of M. Dufresne, a most accomplished and able artist, named among the French members of the jury, all of whom, I have great satisfaction in stating, showed the utmost liberality and fairness in their decisions, and the greatest politeness in their manner, wishes, and bearings towards their colleagues from foreign countries.

"We have," says he, in a report made to the jury, "been altogether much struck, as well with the praiseworthy successes obtained by each nation as with the universal desire to pay increased care to studies in all times useful, but now indispensable for modern society, at a period when all classes, craving knowledge and advancement, desire not only to profit by certain artistic vocations, but to bestow on every branch of life those acquirements which demand science and industry to produce.

"Undoubtedly, in the midst of this general excitement, the peculiar character of each nation is manifested in its peculiar fashion. The English, for example, with a pure mathematical habit, seek that special perfection which may be observed in all their productions. Patient and laborious Germany rests on details and on partial effects. She does not despise difficulties, but exhibits, in 1867, amidst the children of her schools, the same order of ideas as animated her old masters of the 14th century. While we (the French), pupils of Primaticcio, address ourselves to an elegant facility, we avoid the display of labour, too often well satisfied, even too soon sometimes, if we find the whole a happy effort, or that it manifests the artistic spirit. Yet, after all, with every qualification, our national errors, our partialities, we yet are able to affirm, with joyful satisfaction, that there exists a noble elevation and a spirited emulation amongst the greater

number of our peoples. Miserable is that country which, after this Exhibition, cannot comprehend the necessity of progress.

"But the desire to advance," he continues, "is not sufficient. Having given credit and praise to goodwill, we must next, in the spirit of useful criticism and sincerity, expose the peril which, originating in France, is now extending through all countries. We mean the danger of encouraging youth to seek only agreeable and bounded results in the place of directing them towards a serious apprenticeship in the art of correct drawing. The elements of art will ever be the true, the simple, and the beautiful. The inspirations of talent awaken in objects the soul of art. We cannot hope that on all will be bestowed a privilege that really belongs to few. Still, what is necessary at least for all can be accomplished. The boy of the workshop, the artisan, the foreman, the manufacturer, the commercial profession, can learn the simple, naïve, and true proportions of any model presented without being enrolled in the ranks of the artist corps. All ought to know enough of art to appreciate its excellencies, but few should be induced to follow it as a profession. Nor should the artisan be encouraged in the idea that to copy for a year from prints or drawings will make him a Raphael or a Michael Angelo. The teachings will sufficiently have performed their purpose if the pupil can sketch with rapidity the parts of a locomotive, comprehend the divine beauty of an insect or a flower, and can reproduce these glories in cotton, or wool, or silk."

I cannot better conclude than by repeating the remark of M. Dufresne * :—"Miserable is that nation which, after this "Exhibition, comprehends not the necessity of progress."

The information and statistics of this Report have been obtained from documents furnished by the several Governments and exhibitors.

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* He received the gold medal for a most valuable invention in gilding silver by which the health of the workmen will be much benefited. He also exhibited a magnificent cup of chased silver, which rivals work of Cellini.

## Report on Furniture, Clothing, and Food, from all Sources, remarkable for Useful Qualities combined with Cheapness.—(Class 91.)—By R. H. Soden Smith, Esq.



Class 91 is defined as including Furniture, Clothing, and Food of all kinds, distinguished by the qualities of utility combined with cheapness. It is, therefore, an epitome of the important groups 3, 4, and 7—namely, furniture, clothing and personal ornament, and food—and includes thirty-three whole classes, and occasionally objects from some others; but it is distinguished from these, and rendered in some degree special, by the price being required to be stated with every object, as a point for consideration in judging of its merit.

Scope and importance of Class 91.

The importance of the articles forming class 91 is too obvious to require much comment. The degree of their abundance and perfection supplies a test of the advance in civilisation of any country; the home-life of the bulk of the population can be judged of by their use; and, if a comparatively comfortable home-life be secured, by food, clothing, and furniture, at reasonable price, it is needless to repeat here the trite conclusions—which are not the less important for their triteness—as to the moral effect of such advantages upon the humbler classes of any population.

These objects, therefore, of small domestic economy, apt enough to be overlooked or despised in a universal exhibition, have, notwithstanding their little external attraction, an importance of which the ordinary visitor may not be aware, and of which it is not out of place to remind him. They possess, it is true, little external attraction; they are wanting in beauty of form or in excellence of colour, and yet they surround the daily life of the mass of our people, almost insensibly influencing the eye and the mind. It is, moreover, notable that the absence of art-beauty in these homely objects is most conspicuous among nations claiming to be the highest according to the present scale of civilisation. The people whom we are content to regard as semi-civilised—Oriental nations, tribes of Northern Africa, races in the distant parts of the Russian Empire—show an understanding of colour, at least, which renders their otherwise rude household goods models for the skilful European to study and strive to imitate. Art is not thus instinctive among Western nations. The objects that minister to the daily needs and conveniences of common life are for the most part wholly wanting

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—and it is a lamentable want—in every quality that can give pleasure to the eye.

Want of art-knowledge.

The entire household furniture, carpets, fittings, articles of daily use, complete clothing for young and old, may be selected from the contents of class 91, and yet not one object found which ministers in the smallest degree to that art-instinct which is gratified by the commonest productions of Oriental workmanship; neither colour nor form is truly understood by any of those who have contributed their quota to the heterogeneous series which forms this class. Utility is the professed aim of everything exhibited; and, while it may be admitted that this object is often ingeniously attained, it is to be regretted that in its necessary attainment the workman never even deviates into good taste or strays as it were by accident into the slightest appreciation of beauty. Where any exception can be made to this censure it will be found hereafter studiously noted. A French writer, indeed, observes, as one of his conclusions from the consideration of the whole contents of the class, that cheapness has not been obtained, as far as France is concerned, at the expense of good taste. It would be satisfactory could this conclusion be accepted; but not only as regards France, but also with respect to all other countries represented, the writer has been compelled to arrive at one entirely the opposite.

Objects on which art might be shown.

In the objects composing this class, whether furniture, objects of domestic use, or clothing, there is room for taste to display itself, notwithstanding the essential requirement of cheapness, either in general outline, as in pottery; in colour, as in carpets, mats, and clothing; or even in raised surface ornament, as in objects moulded or cast. Among Oriental nations what may be called an instinct of art-feeling guides their work conspicuously in colour, and to a lesser degree in the other sources of beauty. It is not so among the most civilised Western nations—not so in France, any more than elsewhere. The common combinations of colour in the cheap objects exhibited are as false and painful as notes out of tune in music; and the surface ornament is meretricious in character and inappropriate in application. Where traditions of Orientalism still exist, as in Spain, Portugal, and Sicily, art lingers upon household objects—such as the pottery, matting, and parts of clothing. Where manufacture has wholly triumphed in rapidity, certainty, and cheapness of production, the results are usually astonishing examples of the power of making common and really useful objects hideous. In one manu-

facture, at length—namely, in pottery—a step beyond this is beginning to be gained: in addition to the triumph of manufacturing skill, which produces a body and a glaze excellent for everyday use form is occasionally considered, and even colour and decoration that can be commended begin sometimes to filter downwards to the home furniture in stone- and delft-ware of the humble dwellings. This is a pleasant augury for the future. The slightest infiltration of art-feeling is a gain; and we may, perhaps, look forward to a time when household furniture will be cheap and yet cease to be an eye-sore, and when the costume of ordinary life will no longer be absurd in form—take a swallow-tailed evening coat, for example—as well as wanting in every quality that can combine usefulness with beauty or grace.

In the following observations on the objects exhibited, the order in which the various countries are mentioned, and the numerical references appended to exhibitors' names, are in accordance with the French catalogue.

## France.

France. France is more fully represented in class 91 than any other nation, upwards of 500 exhibitors being enumerated, and the variety of objects shown being so great that a bare enumeration of them would occupy much space. It was to be expected that France on her own ground, would largely display objects of domestic use; but it is to be observed that while in the British division of the catalogue a marked poverty and deficiency under class 91 is observable, this deficiency is rather apparent than real, the class being in fact absorbed in other groups, where, under pottery, glass, hardware, and textiles, especially woollen goods, examples are to be found superior in quality at their price to those of perhaps any other country. The British goods of cheap price have not been placed by their producers in class 91, but are shown in their respective groups, where the fact of their low price, for which in some cases they have been chiefly exhibited, is of no avail, and does not receive notice. On the other hand, selections have been sufficiently made on the French side from the contents of groups 3, 4, and 7, containing furniture, clothing, and food to form an extensive and important display of objects to which attention can be directed on the score of cheapness. As regards furniture moreover the park and detached building round the Exhibition are chiefly supplied by the French exhibitors in class 91, who have thus had a practical opportunity of making their productions known.

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It has been remarked that the French objects brought together by more than 500 exhibitors are very various; they range, in fact, from metal bedsteads and garden-seats, through every article of male or female clothing and of personal use, to "articles de religion,"—musical instruments, and thence to preserved vegetables, meat and wine.

Garden furniture.

This heterogeneous assemblage may, however, be broadly divided for convenience of reference, into certain groups; and the first will include furniture and objects of household use. Of what may be called garden furniture, chairs of painted iron, of good design are shown by Letourneur (2), Mutet (11), and others. These are known to all visitors as being the seats chiefly used in the central garden and other parts of the exhibition grounds and building. The seat is formed of iron ribbons curved a little upwards, and thus having sufficient spring to make the seat easy and comfortable. The cane chairs shown by Mutet, and also used for visitors and in the cafés, will be mentioned presently. Wooden garden chairs, the frame of trestle form, the seat and back made of laths with $\frac{1}{4}$ in. between each, are shown by Auge, Auxerre; these, painted green, are priced 2*s.* each. The same exhibitor has light garden open palings, in rough sawn oak, at $4\frac{3}{4}d.$ per square metre ($39\frac{1}{3}$ in.); planed ditto at 6*d.*; painted at $8\frac{1}{2}d.$; a flower-stand, painted, nearly 5 ft. long, of four stages, 5*s.*

Household furniture.

Of household iron furniture, Massé, Paris (1), exhibits a spring mattress, constructed to turn over, so as to be put aside in a small space when not in use. It is made for hospitals and boarding schools; but is inferior as a cheap object of its kind to that shown in Belgium, and alluded to below (Belg., 1720). Bray, Paris (6), has a steel cot of fairly good pattern and workmanship.

Of wooden furniture shown, the chairs by Lefebure, of Versailles (13), are worthy of notice. They are framed in wood, artificially curved, the back and back legs being of one piece, the seat frame formed of another curve with a straight brace in front. The woods used are principally ash, beech, and walnut. The prices, varnished, stained, or otherwise finished, are 6*s.* 4*d.*, 8*s.*, and 9*s.* 6*d.* each. Furniture and other objects made of curved wood have been manufactured for nearly twenty years at Vienna, and these chairs are imitations of the Viennese work, but less perfect than the original. The invention originated with a carpenter at Boppart, on the Rhine; and for years he spent all his earnings in endeavouring to perfect his process. He attained his object, migrated to Vienna, and, more fortunate than many inventors, succeeded in creating a great establish

ment, whose workshops there and in Moravia and Hungary now turn out 700 chairs daily, and half Europe is acquainted with the results of his invention. In the Austrian section are shown some curious examples of this wood curving: double spiral springs of six coils formed of one piece of beech, and arm-chairs, with framework of most ingenious curves; tires of wheels also are thus made in one piece. The present specimens from Versailles possess some, but not all, the advantages of his invention.

Cheap unpainted furniture is shown by Dieudonné and Co., Paris (9), of beech, oak, and deal; kitchen tables and chairs of deal, framed in beech. A chest of drawers of this manufacture, about 3 ft. high by 4 ft. wide, containing four drawers, costs 16*s.*; a dresser, with cupboard and drawers below, about 5 ft. by 4 ft., costs 19*s.* These are roughly made, and inferior to the work of similar material and general character exhibited in the Canada section and noticed below.

J. Viollet, Paris (12), also shows cheap chairs and other furniture. Hat and coat pegs of good make, in oak and deer's horn, are exhibited by Morisot, Paris (10). Chairs, arm-seats for three persons, baskets, work- and other tables, made of rattan-cane, are shown by Mutet, Paris (11). They are strong from the toughness and elasticity of their material; are easy as seats, free from the chill and rust of iron, and light to carry; but the work is rough. A chair costs 5*s.* 8*d.*; a round table, 1*l.* Chairs of this manufacture are employed for the use of visitors in various parts of the exhibition building—a good test of their strength.

Niderer-Bresson, Paris (14), exhibits household furniture, with various coloured covers of plush, velvet, or reps. These sofas, arm-chairs, &c., are not to be commended though cheap. They belong to a style of furnishing frequent in France, but which had better be disused than extended.

Miroy, Paris (19), shows, among many exhibitors of similar articles, chimney-clocks, candelabra, candlesticks, lustres, and other ornamental objects in gilt metal, bronze, and its imitations. These, and such articles of decorative furniture, are a very important branch of manufacture in Paris, and are cheaply produced; it is officially stated that they form the main trade of no less than 30 quarters of the city, from the Quartier St. Denis to the Faubourg St. Antoine; and it is certain that for many such objects Paris is the market which supplies a great part of the world—the carrying traffic being, however, chiefly in English hands. They have a certain air about them which captivates the

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half-educated eye, and which passes for good taste; but they are really, for the most part, beneath criticism on the score of art. They may, however, lay claim to considerable ingenuity and to some prettiness; and it is satisfactory to remark that an advance has been made in some directions in the style of these cheap objects, better designs having been imitated or adapted from ancient models or from the costly works of distinguished artists—thus candlesticks of zinc bronzed, the designs for which are partly Greco-Roman and sometimes not inelegant, are to be bought at a very cheap rate. Bisson, Paris (42), exhibits mouldings and various room and shop fittings, glazed cases, bronzed, gilt, silvered, and oxydised decorations; to all these the remarks above made as to the ordinary character of such showy objects are fully applicable; they belong to a pretentious and often tawdry style, which seeks to bring art down to its own level rather than make the effort to lift itself to the level of art.

The second group of objects may be taken as those of personal use.

Objects of personal use.

Blondel-Duval (73), exhibit spoons and forks of buffalo horn, at 16*s.* 8*d.* per dozen. Nail and tooth brushes are shown by several exhibitors, but not in general of satisfactory quality; those of Boulenger (88) may, however, be noticed. Mathez, Vosges (198), exhibits spoons and various objects of domestic use of tinned iron; but all these, and white iron goods in general in this division, are inferior, price for price, to those produced in England.

Buttons, in horn and bone, and spoons of bone, are shown by various exhibitors; but not of quality or price that competes with other countries.

Bachond-Caillat a Nantua, Ain (69), exhibits turned work of boxwood, similar to that supplied to the London market from Northamptonshire. Powder boxes are priced 7*s.* per dozen. He also shows chessmen, games of loto, &c.; ninepins, these of boxwood, 6 in. high, are 2*l.* 11*s.* 6*d.* per gross of sets.

Odent-Cauchois (86) shows metre and half metre graduated rules, in ivory, buffalo, horn, and boxwood; half metre rules, in boxwood, are priced 2*s.* 6*d.* per dozen. Metre rules less finished, the same price. Rules, squares, and other drawing appliances are shown by Larive (72), Oise; these are cheap. Crosnier-Fleury (82) and Odent (82) exhibit fans, which in point of price can, perhaps, be best compared with those supplied to the European market from Japan; but the subjects upon them want the skill in colour and also

the quaint humour which the Oriental artists throw into their sketches; the French fans can be sold in retail at 2*d.* and 2½*d.*

Feathers and feather brushes exhibited by Loddé, Paris (64), and those shown by Thuiller, Paris (185), are well prepared: the soft feather brushes of Paris manufacture are superior for their price to any to be got at present in England. The points of the feathers are not harshly cut, so that delicate lacquered and varnished objects can be safely dusted with them. They are also well got up and dyed, and the smaller sorts are thus made, if not ornamental, at least not unsightly, in a sitting-room. The trade in these is very considerable in Paris, and they are now exported in some quantity.

Lanterns, candle-shades, and lamps are exhibited; they are of lacquered tin; a dark lantern, at 3*s.* 2*d.*, of gilt metal and brass; a small brass lantern with bull's-eye, neatly made and very portable, for walking at night, is priced 2*s.* 9*d.* Tin and lacquered ware is also shown by Sapy, Haut Rhin (27); but these, in comparison with English hardware goods, do not call for remark.

Pottery.

Of pottery and the cheaper kinds of ceramic manufacture, Dureault, Motte, and Co., Rhone (151), exhibit glazed earthenware printed in colours, plates at 2*s.* per dozen, and other articles in proportion. Gosse, Bayeux (151), shows hard porcelain, test-tubes, retorts, &c., which is stated to be of a quality that has been severely tested. In the annexe to the south-east of the park are larger collections under this head. Stoneware for ordinary use, beer and water jars, ink-bottles, tobacco-pots, match-pots or boxes, &c., are shown by Bosset, Ciry, Saone et Loire (507); also liqueur vessels enamelled within, and other enamelled stoneware. The imitation of the texture and the applied ornament of the old Cologne Grès is successful in some of the cheap tobacco-pots. Boulanger exhibits, from the considerable manufactory at Choisy le Roi, Seine, a collection chiefly of semi-porcelain, marked "granit." This is for the most part of good body, and well glazed. Dinner, soup, and dessert plates, printed in two colours, are priced 2*s.* per dozen; cheese plates, 1*s.* 9½*d.*; dessert, with various subjects "de genre," printed in brown, 2*s.* 10*d.*, with monogram, 2*s.* 2*d.*; printed with well-designed pattern, covering the surface, of arabesques, trophies, &c., in lilac or blue, 4*s.*; dinner plates, ditto, 4*s.* 9*d.* Guerin, Grensur-Loire, shows a considerable collection and variety of "opaque porcelain," answering to our delft or glazed earthenware, but with a style and character very well marked. Some of the patterns on such ware may be regarded as tra-

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ditional in France since the end of the 16th, and some since the beginning of the 18th centuries; others are reproductions from the fine glazed earthenware of Rouen, Nevers, Moustiers, &c., and often very successful; the glaze, contrasted with original examples, is thin and poor in comparison, wanting the creamy quality which brings out the colours on some old Rouen and Marseilles specimens; but for objects of use or ornament in which an effort is made to combine cheapness with effective colour and decoration, the manufacture of M. Guerin is to be commended.

It is not out of place to remark here that under the head pottery, in Class 91, there is no competition on the part of England, no selection having been made by our manufacturers of their cheaper goods; therefore, in commending the French examples a comparison is not intended. The pottery for household purposes produced by Doulton, of Lambeth, for example, is superior in quality of material, in style, and in its most excellent glaze to anything shown at similar prices by any other country; while, as regards the small objects of daily domestic use, there are hawked about the streets of London pieces of cheap pottery altogether better than anything shown in the whole Exhibition under Class 91. A teapot, holding a pint, made with a skill seemingly unknown to the cheap manufacture of France, the dark brown glaze fit to bear heat, and the lid closely-fitted and with a deep ledge, may be bought at a street stand in London for $5\frac{1}{2}d.$; its wholesale price in Staffordshire is small indeed.

Clothing.

Under the head of clothing the number of French exhibitors is considerable, especially of articles ready made; in these the Paris trade, as must be the case in every great city, is very extensive; and some of the establishments whose advertisements on a gigantic scale cover the spaces in Paris left by the Bureau des Démolitions have further taken advantage of the Exhibition to announce themselves.

The clothes of tweeds and other woollen materials exhibited by Jacob-Levy and Simon, Paris (367), are of good substance at their price, generally well cut and made up. A short tourist coat of Tweed is priced 1*l.* 4*s.*; a light grey tweed shooting-coat, 1*l.* 10*s.*, and other articles in proportion. Devillard and Devillette, Paris (366), are principal exhibitors in the class of children's ready-made clothes. Piotet, Paris (368), exhibits shirts of check, &c., blouses, and various calico and linen clothing of fair quality and low price. Cheap felt hats for the poorer classes are shown by Jouany, Bourganeuf, Creuse (398); light grey, at 1*l.* 1*s.* 8*d.* per doz.; darker, and somewhat inferior in quality, at

17*s.* 6*d.* Caps for boys, képis, such as are worn by young cadets, and generally by French school-boys, are shown by several manufacturers; they are, for the most part, of good material and remarkably well got up for their price, the large demand making them cheap. Herold, Paris (405), shows caps in dark cloth, neatly laced with imitation gold or silver cord, at 2*s.* 6*d.* and 2*s.* 2*d.*; others of inferior cloth and with less ornament at 1*s.*; some with gold-lace band, cording, and pattern over the peak in front, at 1*s.* 5*d.* Haas, Paris (407), also exhibits cheap caps. Straw-plaited work from various parts of the south of France, the great seat in the country of the manufactory, is shown by several exhibitors, and taking, of course, price into consideration, is of respectable quality. Rey and Galan (Department, Tarn and Garonne) show straw hats of various styles of plait. Beehive-crowned hats of black and white plait, straw band, finished with straw edging, are priced 3*s.* 2*d.* per dozen. Leborgne and Co., Grenoble (426), exhibit straw hats and trimmings of plait of very good quality, and also at low prices.

Cloth fez caps are shown by Dujoncquoy, Seine and Oise (237), of fairly good cloth, and of excellent colour. Boots, shoes, and slippers have many exhibitors, and in general the form and style is better than a similar cheap class of work would show in England; this advantage might be expected to appear even in the most ordinary foreign work, as the French and many German boot—and shoemakers greatly surpass most of our own in adapting their boots to the form of the foot, and in making them neat, and at the same time comfortable. The difference in respect of neatness between the boots and shoes of the middle classes in London and Paris is very notable; on the other hand, French work is apt to be less solid, and, respecting the important point of the probable durability of the materials in the specimens exhibited, no opinion can be expressed. Chollet, Seine and Oise (416), exhibits strong shoes, riding-boots, workmens' strong boots; the last are of stout brown leather, but it would scarcely seem waterproof. These are priced 9*s.* 4*d.* This is stated to be the retail price; if so, it is very cheap. Canvas shoes and slippers, somewhat similar to, but not so well finished as our gymnasium shoes, are much used in France and Switzerland, and are convenient in warm dry weather, and very cheap. Latour, Paris (413), exhibits them, of rather rough work certainly, but at 1*s.* 8*d.* per pair; the better qualities at 2*s.* 6*d.* to 3*s.* 6*d.* Hempen-soled slippers, resembling the sandals frequent in Spain, mentioned below in the exhibition of Spanish objects, are

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much used in France, especially in the Pyrenean provinces, made with canvas uppers; these, of good quality, women's size, are shown by Salles, Lower Pyrenees (413), priced 7*d.* per pair.

India-rubber waterproof clothing, wrappers, overcoats and leggings, of good material and make, is shown by Engrand and Co., Seine (319), and by Torrilhon, Verdier and Co., Paris (320). Duché and Co., Paris, the large manufacturers of shawls of Cashmere patterns, who exhibit under class 32 (16), show a class of goods here cheaper in style and material. These can only be judged of as regards quality and price by examination and comparison with other specimens; but when thus compared they will be found to be cheap, and they so much excel ordinary productions of low price that they merit having attention called to them.

Food.

The last of the groups into which we have broadly divided class 91 is food; and the collection exhibited by France is of considerable importance and variety.* Chocolate of which the preparation is very extensive in Paris, and the consumption and exportation large, is shown by many manufacturers. That exhibited by Ibled and Co., Paris (452), and prepared with the aid of hydraulic pressure, is of good quality. Ménier, Paris, shows chocolate prepared in a variety of forms, also with much skill and success. It is from this manufacturer that many houses in London are supplied. A considerable variety of preserved vegetables are shown by twelve principal exhibitors; but their preparations require the test of experience to discriminate between them. Such vegetables are, however, much more employed in Continental cookery than in English, and with considerable success. In Holland and Belgium, as well as in France, dinners, during winter, and especially the preparation of soup at that season are much aided by these comparatively inexpensive kinds of food. Asparagus, celery, portions of artichoke, are shown seemingly well preserved, also carrots, peas, kidney-beans, cauliflower, &c. Besides these, which are secured for the most part in bottles, many exhibitors have tin cases of preserved meat and vegetables, fruits, pickles, vinegar; liqueurs and wines are also shown. Guillaut, Paris (437), exhibits cakes of gingerbread similar to those for which Amsterdam is noted. These are sold, according to quality, at 5½*d.* to 7½*d.* per kilogramme.

* It may be noted that the position of this collection is such that it may be easily overlooked, being wholly out of its order—if any order can be said to be even attempted, much less adhered to. The collection is shown in a separate small court, on a line with the cafés, and is entered from without the building. Another important section of class 91 is in a remote "annexe," on the extreme south-east of the park.

## Belgium.

Belgium.

The objects shown are not numerous. They consist chiefly of textiles, and iron and wooden furniture. It would seem that the collection in class 91 suffers in the Belgian division, as it does on the English side of the Exhibition, from the circumstance of articles which might fairly have come within the scope of the class being shown in their special groups, without consideration of the question of their cheap production.

Textiles.

Lemaieur, Brussels (4), exhibits shawls, wrappers, and various woollen goods, tolerably exact reproductions of Scotch style and pattern, of good quality at their price; for example, a tartan shawl, not the cheapest make, about 5ft. 6 in. square, is priced 6*s.* 6*d.*

Furniture.

Ruelens (1720 in Belgian catalogue) exhibits an iron spring bedstead, about 3ft. 6 in. by 6 ft., efficiently constructed with ribbon instead of coil springs, thus gaining the advantage of a spring mattress. This is cheap (1*l.* 4*s.*) Compare in construction with those noted under France (Massé, No. 1).

Messrs. Cambier, De Blauw, and Verheyden exhibit chairs of cherrywood and beech. Of these the best at their price are the folding cane-seated and backed chairs of Cambier (1), in varnished beech, at 4*s.* 2*d.* The same maker produces a varnished cherrywood chair, cane-seated, at 3*s.* 2*d.*, and a beechwood ditto at 2*s.* 6*d.*

## Baden.

Baden.

Dr. H. Meidinger, Carlsruhe, exhibits a sitting-room stove, constructed of dark tiles of a good chocolate-brown colour. It would not readily show discolouration by smoke or heat, and is so far well adapted to its purpose. The general plan of the stove is good, but it is not skilfully put together, and the glaze of the tiles is not of first-rate quality.

## Austria.

Austria.

The objects exhibited by Austria in class 91 are numerous and of very various character. Among those calling for observation are the following:—Elsinger and Son, of Vienna (No. 4), exhibit waterproof clothing and travelling objects; the former are light and seem to have a surface sufficiently tough and flexible to wear well. Driving capes and coats, leggings and gaiters, are shown; of the former a thin black waterproof coat, buttoned, and with loose sleeves, costs 12*s.*; a white, of better quality and finish, 15*s.*; gaiters 2*s.* 6*d.*; haversacks of the same material. They also exhibit a water-

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proof tissue for hospitals, at 1*s.* 8*d.* per metre (39$\frac{1}{3}$in.) of a very tough and durable texture. This is a valuable and cheap material for its purpose.

Unterwalder, of Vienna (27), exhibits tarpaulins of strong but rough texture ; no information respecting their price has been furnished.

Wooden blinds.

Attention is especially to be directed to the preparation of wood for matches and for window-blinds, screens, &c., the specimens shown for these purposes by Austria being superior to any exhibited by other countries; the wood is straight-grained deal, and, by means of planes made for the purpose on the principle of moulding-planes, it is cut into rods of $\frac{1}{8}$ in. or less, in diameter and 3 ft. or 4ft. long. From these rods the small round Viennese match-boxes, with which we are familiar in England, are filled; the long pieces are made into sun-blinds and screens of excellent construction, which are light, strong, and roll into small compass. For these the demand is great, the inexhaustible supply of wood which the Austrian fir-forests yield affording cheap material.

Matches.

The process of the match manufacture which at present enables Austria to supply, in great measure, the English market, might, it would seem, be introduced with advantage into towns like Gloucester, where the large importation of wood supplies material and where the manufacture of matches is already established, but by processes less economical of labour. Schuberth, of Ottakring, near Vienna (23), is the principal exhibitor of this prepared wood, and the blinds, &c., made from it. Franz Reif also exhibits wood prepared for matches, frames for seives ; thin deal veneers, for match and other boxes; sabots, and wooden spoons.

Porcelain-headed nails of various colours, for furniture and for fastening down carpets, are shown by No. 23, above mentioned.

Among domestic utensils are to be noted the wooden staved and turned work shown by Neumayer, of Vienna (18); barrels, tubs, churns, bread-platters, &c. The staved and hooped work is good ; barrels, for example, composed of various woods ornamentally arranged and well fitted. Their prices may be judged from the following : barrel with moveable cover, chiefly oak, but composed like a Scotch quaigh, of several woods, about 1 ft. by 9 in. at its greatest diameter, 7*s.* 2*d.*; barrel-churn, of oak, brass hooped, with fittings, about 15 in. by 12 in. 9*s.* 6*d.*

A useful beefsteak beater is shown by Simon Marth, of Vienna (14); a wooden clothes-horse, by Weiss and Son, Vienna, similar in plan to that mentioned under Canada, is priced 5*s.*

Some of the cast-iron household objects shown in class 40 (19) come also within class 91, as cheap utensils of domestic use; iron pots and skillets, enamelled within; a pot, well enamelled, 14 in. deep by 10 in. diameter, is priced 4*s.* 2*d.*, and so on, in proportion to weight and size; a skillet, 7 in. diameter, 2½ in. deep, enamel-lined, 10*d.*

Beschorner and Co., Vienna (2), and J. Fr. Mayr (15), exhibit sarcophagi and coffins in metal and marble. Beschorner exhibits cast-iron sarcophagi, bronzed, silvered, and brown, lacquered, with gilt handles, plates, and ornaments, varying in price, according to size and finish, from 10*s.* 6*d.* to 36*l.*

## Spain.

Spain.

Of the few objects shown by Spain in class 91 the following deserve notice:—

Matting.

Manuel Mas and Son (1), from Crevillente, in the province of Alicante, exhibit matting of grass and rush, which forms an exception in one respect to most objects shown in the class. It is exceptionally good in point of taste, the specimens being for the most part woven in diapers of various colours, the diapers well designed, and the colours generally suitable and harmoniously combined. A fine Turkey red, yellow, and purple are employed, the colour of the grass being itself of a good yellowish tone. Some of the diapers are minute and very skilfully woven on a hemp warp. The coarser matting is plaited. One of these, rich in colour, of red, yellow, and purple, about 6 ft. by 3 ft. 6 in., of very strong material, but rather rude work, is priced 6*s.* 6*d.*

Sandals.

Sandals of strong material and low price are shown by N. Peranton (2). These—in Spanish, *alpargatas*—have soles about half an inch thick, of twisted hemp, an edge of strong web, and black tape bands. For the army they are produced at less than 19*s.* per dozen. A better quality are 2*s.* 2*d.* per pair. (See the slippers noticed under France, No. 413)

Similar sandals are shown by Miguel Casayus (4), from Huesca, and also another kind (*alborgas*) woven of tough bent grass, with toe and heel piece of the same material. These are sometimes gaily coloured by wools—scarlet, purple, &c.,—woven with the grass fibres, and are also manufactured very cheaply.

Caps.

Caps worn by the peasants and others are shown by the Sociedad Economica de los Amigos del Pais (Economic Society of friends of the Country): these are from Murcia. Catalonia also sends scarlet and purple long caps of cloth similar to those worn by Italian peasants at Spezia and elsewhere on the coast. The scarlet dye is fine and the cloth

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fairly good. These cost only from 1*s.* 7*d.* to 2*s.* Some textiles are shown, but do not call for observation.

## PORTUGAL.

Portugal. Pottery.

In class 91 Portugal exhibits various Pottery, and among the specimens shown are some which, while they can be commended for the qualities of fitness and cheapness, that specially bring them within scope of class 91, deserve also to be noticed for satisfactory colour and forms of good outline. The texture of the porous pottery is good, and well fitted for the purpose; some of the other kinds want strength and solidity. A green glaze used, on many pieces, is admirable in colour, and varies in tone sufficiently to escape the dead monotony and flatness often remarkable in English and French glazes. Several pieces are made in direct imitation of old English ware, some marked with the Davenport anchor. They are inferior in texture to but better in colour than their prototypes. The principal exhibitors are the Commission of Poyares and others, from Coimbra. Eugenia Vasconcelles (9), from Lisbon, exhibits some vessels of cheap character notable for good form.

## ITALY.

Italy. Chairs.

Chairs and specimens of straw and willow plaiting are the objects of exhibition most to be noticed from Italy. Of the former, those shown by J. Canepa (17), from Chiavari, Genoa, and by L. Descalzi (18), are to be commended. Most of their specimens come fairly into class 14 of furniture, but some for plain household use are included in class 91. They show well-made light chairs of beech, maple, &c., with woven white willow seats, varnished wood, at 3*s.* 4*d.*, and stained at 3*s.* 8*d.* Straw-plait is shown by J. F. Bo (25), from Sestri—hats of cheap work and material, chiefly for the peasant class. V. Bertolani (27), from Modena, exhibits willow-plait, for hat-trimmings, of even work and well-prepared material.

Straw-plait.

## CANADA.

Canada.

Class 91 is represented in Canada by objects of considerable importance, though the number of exhibitors is small. One of the valuable industries of the country is the home-manufacture during the long winter, of woollen stuffs, cloths, shawls, blankets, &c.; these employ the females of the families and the young women generally in the farmers' households, and the results of this home-work as shown in the Exhibition are most satisfactory.

Mdme. Bouchard, from St. Valier (1), exhibits various stuffs made with considerable skill, of excellent material, and apparently of the most durable character. In classes 28 and 30 she also exhibits strong unbleached linen of home manufacture at 1*s.* per yard, and dark check, a stout material for plain dresses, at 1*s.* per yard. Marcel Fortin (11) shows stout woollen cloth of dark dye, 3*s.* per yard; good grey material, fit for shooting-suits, 3*s.* 6*d.* Mrs. Chandler (12) and James Busted show woollen socks and stockings of good quality, also of home manufacture. The conditions of the production of these objects at a period of the year when the severity of the climate causes a cessation of much ordinary female industry, and when a practical and profitable resource is of double importance, give their manufacture a greater social value than its extent would otherwise entitle it to claim; moreover, their excellent quality for purposes of domestic use and their cheapness, considering this quality, claim notice and commendation.

Woollen and linen goods.

Messrs. Jacques and Hay (2) and Owen M'Garvey, Montreal (3), exhibit household furniture, perfectly plain in character, commendable for its substantial make and cheapness. The work is thoroughly honest, unpainted, or varnished, having the surface finished up with glass paper; each article delivered in pieces for putting together. Oak and hickory are the woods chiefly used, the lighter parts, where no stain occurs, being of white pine; almost the whole is machine-made. A chair of hickory costs 1*s.* 3*d.*; an armchair, 2*s.*; a chest of drawers, about 3ft. 6in. high, framed of oak, with hickory mouldings and white pine drawers, costs 15*s.*; locks and neat polished handles are forwarded for fitting on, and these are extra. This furniture is almost entirely made for exportation, and the West Indian islands are the chief market.

Furniture.

The portable folding clothes-horses—four moveable arms radiating from a centre—as well as the louvre shutters for windows and meat-cupboards, exhibited by George Hager and Co., Montreal, and made at their factory, Shearers Mills, Lachine Canal, Montreal, come within class 91, as examples of convenience and economy: these are all machine-made, of hickory and white pine, and are manufactured chiefly for exportation.

In the preceding report incidental allusions only have been made to articles exhibited by Great Britain. In point of fact, our own country cannot be said to be represented at all in class 91, the objects, as has been already observed, that would have fairly come within the class on the score of their cheap production being distributed under their several heads

Great Britain not represented.

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in other groups, and no selection having been made by their producers to illustrate the very class which would have explained the condition and quality of their manufacture. Thus, the country which supplies the greater part of the world with cheap manufactured goods is unrepresented in an exhibition of the very articles of her principal commerce. In some instances, indeed, this failure seems to have been accidental. Amongst the woollen goods sent by Messrs. Firth, of Heckmondwike, Yorkshire, were some intended for class 91, as examples of cheap manufacture; but they are shown in class 30, No. 29, where their quality of cheapness is not necessarily noticed. This has been the case with others, also. There remain, therefore, but a few objects, to be found by diligent search in the British section; and it has not been thought so necessary to draw the attention of the visitor to them as to others, even similar in general character, shown by foreign countries. Among aids to domestic economy and convenience, it is, however, right to mention that the well-known knife-cleaning machines of Geo. Kent, High Holborn, are exhibited. The asylum at Redhill, Surrey, has sent proofs of the industry of its unfortunate inmates; and the Society for Promoting Female Education in the East shows needlework, &c. Silver and Co., London, exhibit ready-made clothing and various objects of household use, at very low prices.

Conclusion

In conclusion, without recapitulating the few observations made at the commencement of this report, some emphasis may be added to them by noting the following points which forced themselves on the writer's attention while studying the mass of various articles which constitute this very comprehensive, and socially most important class:

1st. A great advance has been made by some continental nations, notably by France and Belgium, in competing with Great Britain in the supplying of cheap goods and objects of daily use: the textiles of Belgium, some of them in direct imitation of our Scotch woollen goods, are an example; so also are some of the water-proof clothing, and the pottery and porcelain produced in France.

2nd. Continental nations still completely retain some minor branches of industry which could be advantageously pursued by Great Britain, and largely share in other manufactures; many of the "articles de Paris" may be instanced; also hat, glove, and silk manufactures.

3rd. The relative success of foreign competitors has been obtained by improvement in machinery, in processes of manufacture, in more ready supply of raw material, in additional facilities for transport and exportation, not by

the development of other and higher sources of success to which allusion will presently be made.

These observations touch more especially matters affecting Great Britain, but the following are applicable more or less to all countries exhibiting:

4th. The effects produced upon the objects composing class 91 by the conviction to which their manufacturers have more and more yielded that success in trade can scarcely be attained except by the supply of articles at small profits to large numbers of purchasers.

*a.* The consequent necessity of rapid and vast production with the necessary intervention of much machine-work between the original brain-labour that conceived the object and the ultimate result.

*b.* The increase in production in the direction of inferior and cheap goods rather than in those of higher quality; centres of manufacture formerly notable for a high class of products are now in many cases given up almost wholly to the trade in cheap and inferior goods.

5th. The great room there is for improvement beyond what has hitherto been achieved in the production of almost all articles various as they are, that come within the scope of class 91, not only in design but in adaptation to their purposes, in material, and in manufacture. It is scarcely possible to conceive anything more false in taste, more absurd in the application of what is miscalled ornament than the majority of the objects displayed in class 91; nevertheless, in many cases the application to these articles of a very little true art would instantly raise their mercantile value. Roubiliac's drawings and Flaxman's designs gave money value to Wedgwood's pottery even at the time when it was produced, and Wedgwood well understood this. As far as the requirements of cheap manufacture go, it would be almost as easy to produce carpets, rugs, and mats at least inoffensive to the eye as to weave things that are hideous; an oriental workman using his inheritance of art-practice goes right as it were by instinct; at this side of the world art-education is needed, and no comment on that want could be so cogent as a visit to class 91 in this Exhibition.

6th. The probable social effects of the great difference still existing between the cost of production and the retail price of an article to the poorer class of purchasers; a difference which suggests to these classes the economy of associations among themselves, such as are already at work in some localities, for the production and supply of articles of daily consumption.

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Finally, it is obvious that if Great Britain is to continue competing successfully with her continental rivals in the supply of articles which surround the daily life of millions and which represent a trade encompassing the whole globe, her manufacturers must bring to bear on their business higher qualities than are commonly deemed necessary for money making; qualifications, some of which at least must necessarily be sought beyond their own body—inventive capacity, knowledge and practice of art, wide acquaintance with new materials, and scientific skill to make them available.

No other than brain labour and that of sterling quality will enable supremacy in manufacture to be retained, and that brain labour becomes more and more difficult to depend on as superficial systems of hurried education, with some special examination always in view, come into use for those who ought to be trained to power of thought not merely to hasty acquisition of ill-assorted facts.

## Report on Dwellings characterised by Cheapness combined with the Conditions necessary for Health and Comfort.—(Class 93.)—By Edwin Chadwick, Esq., C.B., Correspondent of the Institut.

Mr. Chadwick on Dwellings.

It may now be taken as proved to all who have a competent knowledge of sanitary science that fully one-half of the diseases which afflict the wage classes in the towns, and in many rural districts of Great Britain, and, more or less so, those in the Continental cities, are occasioned by local causes in or about their dwellings, together with the misuse of their dwellings by overcrowding. This has been demonstrated in various instances in towns. Indeed, from particulars furnished to me by the late Sir Charles Phipps in relation to the death rate prevalent amongst the cottagers on Her Majesty's estate at Osborne, where attention has been directed to their sanitary condition, it was manifest that if the like attention were paid to the sanitary condition of the dwellings of the wage classes throughout the United Kingdom, their general death rate would be about one-half what it now is, even in the rural districts.

Extent of disease and premature mortality preventible by improved dwellings.

Considering the vast extent of evil which is proved to be preventible by improved sanitary constructions, it must be confessed with regret that the Exhibition presents evidence of only incidental and an utterly incommensurate amount of attention to the great subject; and that the model dwellings erected within the precincts of the great building, with one exception, display no advance in principles, and no important improvement in construction, and, in one most important point, a falling off from those which the careful judgment of H.R.H. the Prince Consort adopted and displayed in the model dwellings which he caused to be erected in connexion with the International Exhibition of 1851. Nevertheless, an extended attention to this important subject has followed that first public exhibition of a model dwelling, and important efforts of special interest to those who appreciate it are presented in this Exhibition. France, which had no model dwellings in connexion with its Exhibition of 1856, has now six models constructed; Prussia has one, and Austria one. England has only plans and models, of no novelty or special merit, that are not familiarly known, and may be passed by for further improvement.

MR. CHADWICK ON DWELLINGS.

The leading Continental example of model dwellings within the Exhibition is one, a block of four, a type of the new houses of the wage classes of a new town, or cité ouvrière, constructed in connexion with the manufacturers of Mulhouse.

The foremost minds of France, of the Academy of Moral and Political Science of the Institut, had their attention directed to the manifestations of misery and disorder concurrently with the spread of manufactures in its chief cities. The late Dr. Villerme, of the Institut, visited and examined the condition of the working classes in the manufacturing towns, and drew a frightful picture of the drunkenness, misery, and physical and moral disorder in which he found the wage classes of the new manufactures heaped together in old or temporary habitations. The Academy deputed another of its distinguished members, M. Reybaud, to continue and extend these investigations; and he has prepared able reports on the progress of the cotton, woollen, and silk manufactures. M. Jules Simon, also of the Institut, has devoted himself to the task of visiting and examining the condition of the wage classes, and stated his results in two masterly works, "The Workwomen" and "The Workmen." In my own view, if I may venture to say so, my honoured colleagues of the Institut have even yet fallen short in their estimate of the demoralising influences of bad physical conditions, or the means of their removal. A comprehensive review of the economical and social results of the efforts made up to this time, which may be commended to all who would study the subject, is contained in a work, "Les Institutions Ouvrières de Mulhouse et des Environs, par Eugène Veron." In this last work will be found interesting narratives of long fights maintained by benevolent and enlightened persons against misery and ignorance, in which he shows how inferior were the results of all measures of cure and alleviation by charities, and how superior were the results of well directed exertions in the way of prevention, under the leadership of M. Jean Dolfus, an eminent manufacturer, the present Mayor of Mulhouse, who deemed the great point of attack on the progressive mass of evil to be in the amendment of the habitations. He has told me that his own thoughts took this direction from a view and study of H.R.H. the Prince Consort's model dwellings attached to the International Exhibition of 1851. M. Dolfus first got a plan of a house with four dwellings, made by M. Muller, a local architect, with modifications considered to be adapted to the people and the country, and had it built as a trial work. He then got up a society, under the title of the Société des

Prince Albert's model dwellings the leading type for the Continent.

Cités Ouvrières," with a capital of 300,000f.; and, out of 60 shares, took 35 himself.

His Majesty the Emperor has always been in advance of political parties in his special regard for the welfare of the wage classes, and his desire to improve their physical condition. In 1849 there was erected, under his direction, as President of the Republic, a cité ouvrière of Paris—that of the Rue Rochecourt. Shortly afterwards, by decrees of the date of Jan. 22 and March 1852, a sum of 10,000,000f. was allotted for the amelioration of the dwellings of the labourers in the great manufacturing cities, from which grant Mulhouse derived some aid. But of the cité ouvrière it must be said that although devised with a view to economy its construction was ill-advised and unfortunate; for, with the aspect of a barrack, it had not the complete independence of each tenement which is maintained in the houses of Miss Burdett Coutts and Mr. Peabody, and in other recent constructions; as also in the construction of "flats," or dwellings for the higher classes, such as those in Victoria Street and other places.

Failure of cités ouvriers in France.

The ouvriers of Paris refused to be what they called "caserné," or "barracked." The result of this well intended effort has, I apprehend, been to retard progress; for, where it is necessary for the wage classes in manufacturing towns to be near their work—a necessity which is increasing with us—where land is consequently high priced, it follows as a collateral necessity to construct what I have called "perpendicular streets," to save the heavy ground rents of horizontal streets, and also to do something on narrow space, where wide space is not obtainable at any price. There are moreover, in the massive constructions various economies and collective advantages obtainable beyond those which are to be got for small separate cottage constructions—e.g., common wash-houses and drying-sheds, baths, common store-rooms, &c.; and a better future—for improved water supply, improved drainage, warming, lighting, and ventilation—than is yet furnished for single tenements for the wage classes. Moreover, the report of the working of detached or semi-detached or widely spread suburban dwellings, with cheap railway transit, for the wage classes, is not entirely favourable. The wives find it dear to be at a distance from the town markets and the town shops as also from their work. The men make one complaint, which would not commonly be anticipated—that, after a hard day's work they feel the vibration of the common railway carriages, as they are now constructed, to be peculiarly disagreeable to them, if not injurious. They, many of them, say they feel

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after a few weeks' use of railway travelling, they have an increased degree of lassitude beyond what they had before, and are not so well up to their work as they were in their town residences.

At Mulhouse, the distance from the manufactory of the land available for the new company was not very great. "After due deliberation," says M. Veron, "the committee unanimously rejected the principle of the great barracks which had so ill succeeded in Paris and elsewhere. If these buildings have the advantage of economy and ground-rent and cheapness of construction, they have on the other side, in the agglomeration of the population, a crowd of inconveniences, the least of which is the repugnance of the working classes to this sort of dwellings."

Several modifications of the principle of detached dwellings were tried at Mulhouse; but that which, after some years of trial, has been found the most eligible, is the one exhibited in the garden of the Exhibition, on the principle of the Prince Consort's cottage of four houses under one roof, occupying, however, each a perfect quarter of a square, separated by a double wall, light and ventilation being received at the gable end as well as at the front. The ground occupied by each house is about 45 yards, and each has about 144 square yards of garden extending in front of the house and a part of the gable to the line of the wall of the next house.

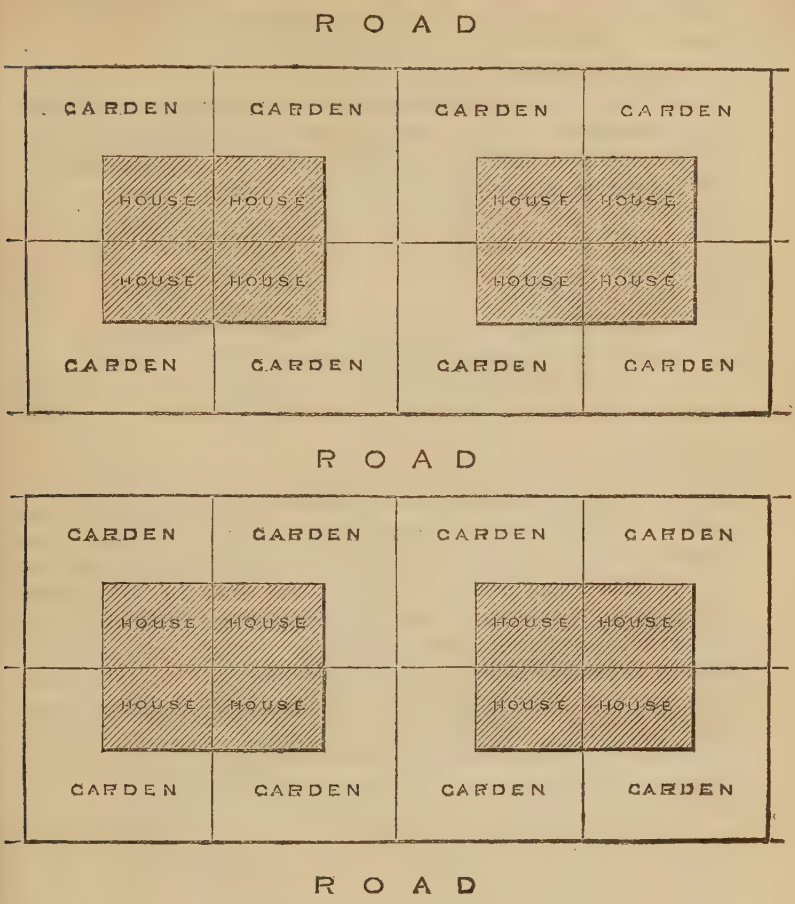
The Mulhouse plan.

The following is a portion of the plan of a Mulhouse village (*see next page*).

External ventilation of dwellings.

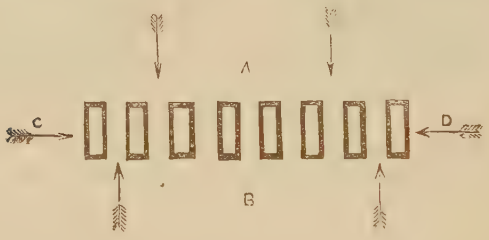
The sanitary advantages of this arrangement of the dwellings, primitive as it is, as parts of a town, consist in the more free sweep of air through the town and better external ventilation of the dwellings, as well as the advantages of the garden, for children and the family in fine weather. But from various plans exhibited of blocks of dwellings of the wage classes it appears to me that further attention is required to be paid to this subject of external ventilation in the arrangement of buildings and of towns, which it may be well to notice for the sake of new colonies as well as new suburbs.

Some of the healthiest and strongest populations, at least in England, are those living in detached cottages on high elevations on granite, sandstone, or other primitive rocks, where, from the indifferent carpentry, or loose window fastenings, the cottages are constantly ventilated externally as well as internally on all sides, despite of themselves, where the ground about them is frequently storm washed, where the water they get is soft and pure, and where their food is ample though simple, of oatmeal, potatoes, meat, and unlimited

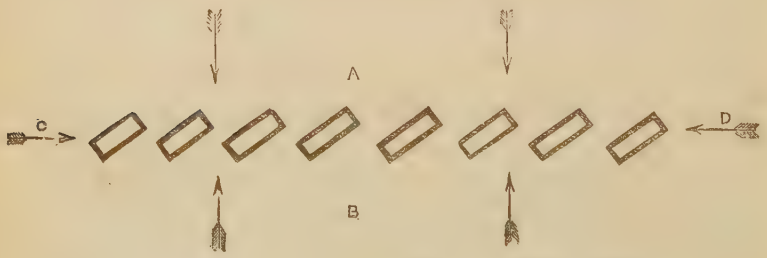



supply of milk or butter-milk. A frequent arrangement of dwellings of the wage classes, as displayed in several plans adopted by the army sanitary commissioners of blocks of dwellings connected with manufactures is often in completely or nearly-closed squares, constituting reservoirs or wells of stagnant air, which becomes vitiated. In the arrangement of hospital huts, the subject of external ventilation is often well attended to, and their plans may be presented for consideration in suburban districts or in rural districts where the price of land is not a serious obstacle. Thus the common arrangements, even of detached dwellings, should be avoided on low ground, or on all but exposed situations. Thus on this usual arrangement, the winds blowing from the

directions A and B are the only winds which would sufficiently ventilate each hospital hut or dwelling. Any movement of the air from the points C and D will be arrested by the end huts, and the effluvia from the huts would be carried from one end to the other along the line;—air moving from all intermediate points would be more or less interrupted, and free external ventilation interfered with.

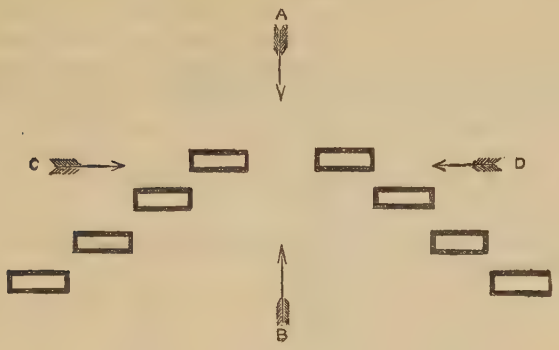



A modification of this arrangement has sometimes been adopted which to a certain extent obviates these objections. It consists in arranging the hut in two lines instead of one line with the huts more apart, and so placed that a hut in one line is opposite to a space between two huts in the opposite line. But each line will be subject to the same condition that the wind can only blow beneficially upon it, at right angles to its direction. If, however, the huts or dwellings be arranged in echellon, the advantage obtained in external ventilation becomes apparent.

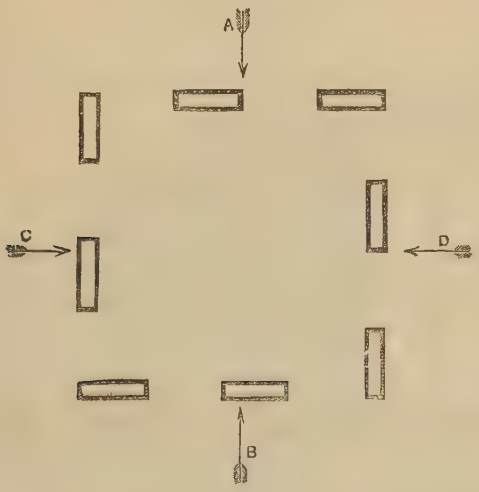



It will be seen that in whatsoever direction the wind blows, it must sweep freely round the huts. When it is practicable to obtain the full benefit of the prevailing winds the sides A or B should face them. If the ground should not admit of such a length of line the cottages may be arranged in double echellon, the lines being kept at a

sufficient distance from each other, or the line may be bent thus:— MR. CHADWICK ON DWELLINGS.




But it is possible to enclose a space within and yet to retain the advantages of full ventilation, as thus:—




In the arrangement of close urban blocks of dwellings and in laying down new colonial sites, the plan of Sir Christopher Wren for the rebuilding of the city of London after the great fire may be advantageously studied for the introduction of diagonal and polygonal lines, which admit of a better sweep of air and external ventilation, as well as better lines for traffic, than the square closed block, plans on Arrangement of lines of streets.

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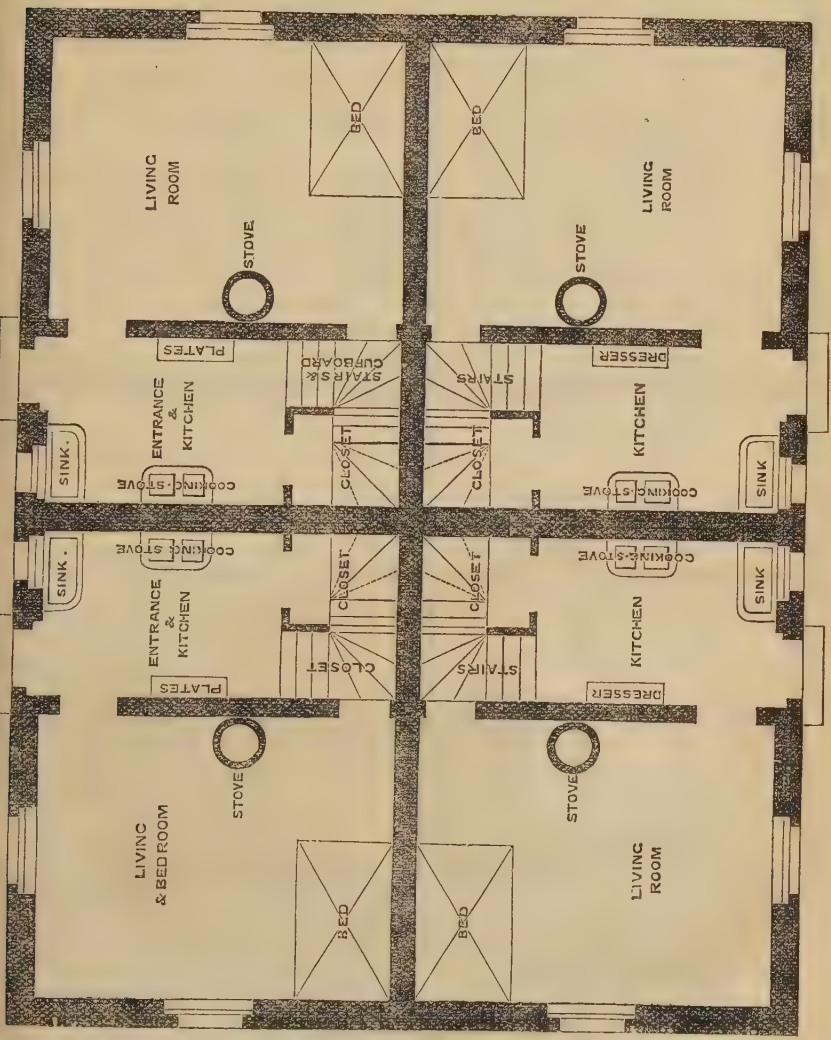
which urban districts are commonly arranged. In the improvement of Paris the diagonal principle of arrangement has been advantageously adopted. In all these arrangements care should be taken to keep the lines open to the suburbs, and not allow them to be crossed or made dead ends, by other dwellings. In the instances even of hospitals, as well as in private dwellings, I have seen too many instances, where the internal ventilation ended in pumping in an almost worse external air from closed streets or courts, in which the air was stagnant and vitiated by the want of external ventilation.

The following are sketch views and plans of one block of the Mulhouse dwellings.

SKETCH VIEW AND PLANS OF ONE BLOCK OF THE MULHAUSEN VILLAGE.


LIVING ROOM
BED
STOVE
PLATES
ENTRANCE & KITCHEN
COOKING STOVE
SINK.
CLOSET
STAIRS & CUPBOARD
STAIRS
LIVING ROOM
BED
STOVE
DRESSER
KITCHEN
COOKING STOVE
SINK
CLOSET
STAIRS
ENTRANCE & KITCHEN
COOKING STOVE
SINK.
PLATES
CLOSET
STAIRS
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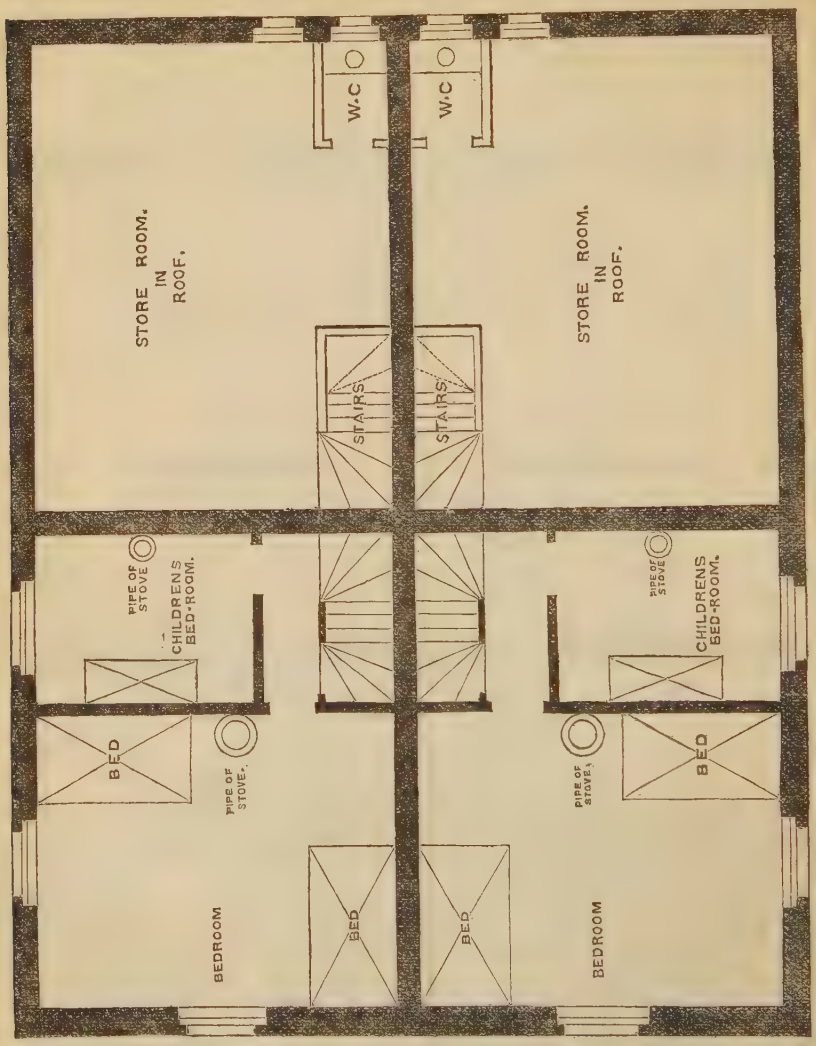
Ground Plan.




Chamber Plan.

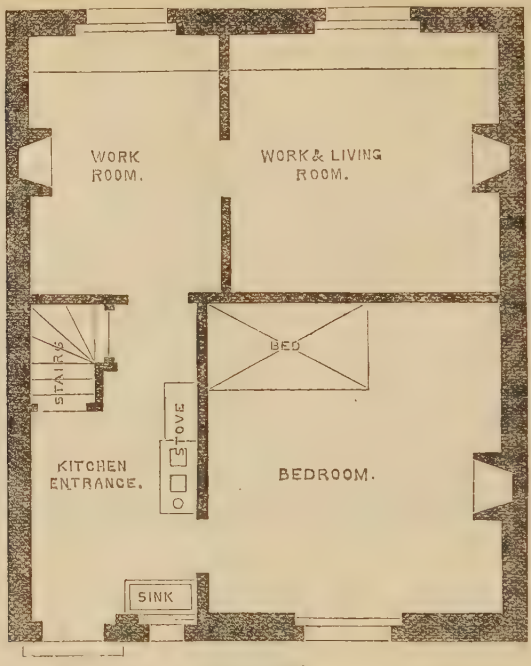
It appears to me that the plan is good, and that several internal sanitary arrangements are very good in principle. I shall, however, reserve some observations on details of the construction of these dwellings until I am enabled to make them comparatively on the same points in the other dwellings to be noticed in connexion with the Exhibition.

The cost of each house complete is 3,000f., or 120*l.*, with the adjuncts of the garden, the kitchen, the cellar, and the loft. They are sold to the workmen, who pay for them, first, by an advance of 250f. or 300f., and then by annual

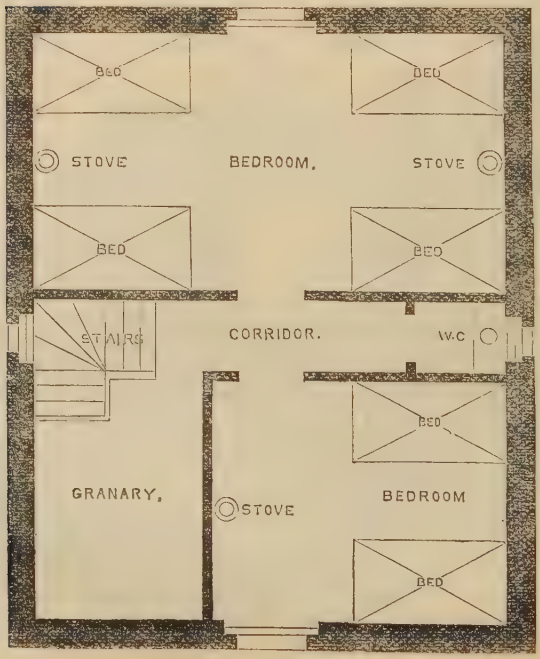
instalments of principal and interest, so as to become proprietors of their houses in fourteen or fifteen years. Out of 692 dwellings constructed by the company up to August 1865, 640 were sold, and the financial operations of the company were completely succesful. The example was followed at Guebwiller, by the manufacturers of the distinguished house of Bourcart, where 139 model houses have been constructed of which 49 are attached to the manufactory of the Messrs. Bourcart thomselves, who do not sell, but let them to their own workpeople. Another company has been formed with success at Beaucourt; and the example of these three places has, it is reported, given a great impulse to the construction of improved dwellings in other manufacturing towns of France. As an advance upon almost single chambered dwellings, the Beaucourt cottage, for the village watchmaker, and the village tailor, with the work room and living rooms combined, are deserving of notice as a distinct species.

SKETCH VIEW AND PLANS OF THE BEAUCOURT COTTAGE.

MR. CHADWICK ON DWELLINGS.




Ground Plan.




Chamber Plan.

Other sets of buildings, and the foundations, indeed, of new towns, are declared to have been originated in other Continental states by the influence of the successful example set by the Prince Consort at the Exhibition of 1851.

Economical principles of dwellings, construction, and holdings.

At the present time three distinct economical principles for the provision of improved dwellings for the wage classes are brought under consideration in relation to the chief examples in the Exhibition. 1st, that of ownership by the occupant; 2nd, that of the occupation of dwellings constructed and owned by the employer; 3rd, that of the common renting of the tenement for weekly or various periods. The 1st is chiefly the principle of those buildings actually constructed and contributed from France in the Exhibition, the 2nd the buildings constructed by Mr. Titus Salt, of Saltaire, near Bradford, of which plans are exhibited in the British department. I was sorry not to see in the Exhibition the plans of what is reported to be a highly-distinguished example of workmen's dwellings, with adjuncts, baths, &c., built by M. Godin Lemaire, of Guise, for the 600 workmen he employs, near St. Quentin, in the manufacture of kitchen ranges, grates, and stoves. Of the third principle, that of the ordinary renting, the chief examples offered in the Exhibition are from England; those of the metropolitan society for the improvement of labourers' dwellings, and those of Miss Burdett Coutts, Mr. Peabody's, and the Waterloo buildings. Each principle has its advantages for application under different conditions. The success of the proprietary principle (of which there are various legal administrative conditions for the study of imitators, open for examination in the buildings at the Exhibition) is reported upon by trustworthy observers as most conspicuous and decided for the wage classes, as well as the capitalist, at Mulhouse. The repeal of the pernicious law of parochial settlement in England, and the increasing scarcity of labour, are beginning to create a competition for good, steady, and respectable labourers and their families by the erection of comfortable dwellings by proprietors. And the question is beginning to be widely entertained as to the most eligible principle of construction. When intelligent capitalists and manufacturers take the matter up it may be anticipated, from examples already given, that a higher degree of comfort may be anticipated than is or can be attained by individuals of the wage classes. On the third principle of ordinary renting, it is to be observed in the interests of those classes that the investments of the most advanced in intelligence may often be more conveniently and economically made otherwise than in fixed habitations. A study of the chief products of the Exhibition will show that the future condition of manu-

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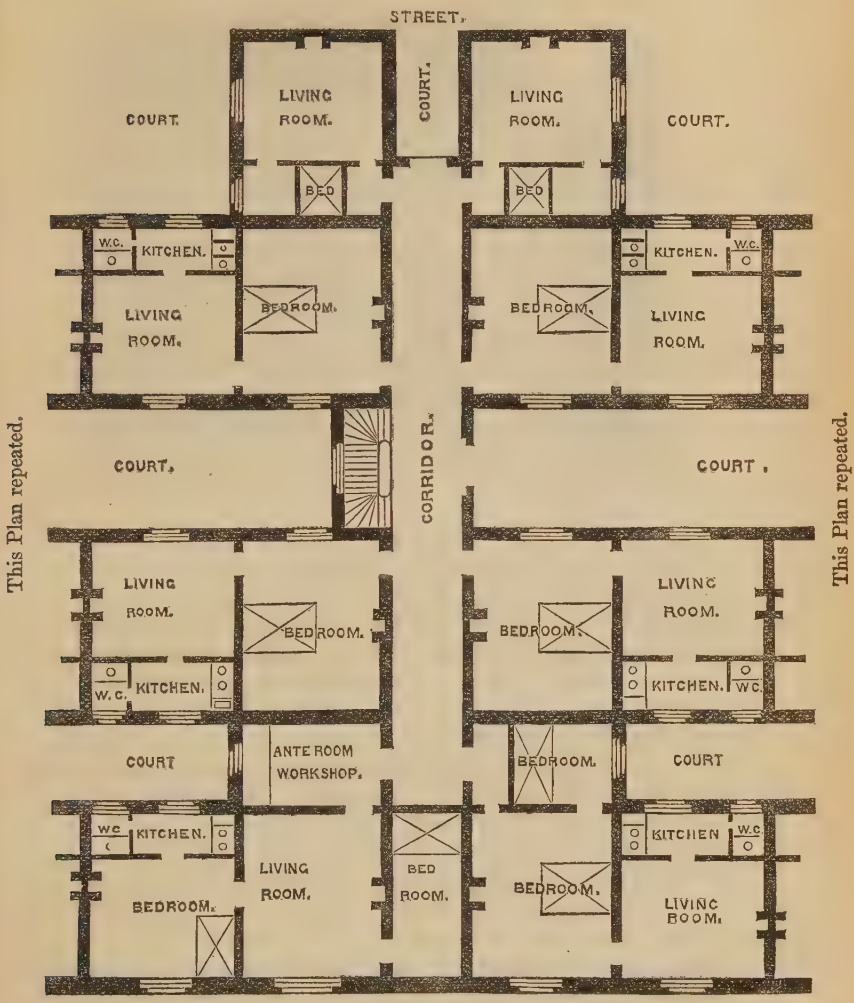
factures, as well as the present, will be a condition of great change in their location as well as in their subject-matter, —of change from province to province as well as from one part of a city to another. In these changes the wage classes must participate, of which I might adduce large examples. In poor-law administration I have been concerned in sales of small properties, chiefly cottage property, to the amount of nearly a million sterling, which, by such changes, or by destitution, or by death and want of competent succession to the property, have fallen to the local administrations. At Mulhouse, however, changes, by the death of the family, by the terrible conscription taking away one of its most productive members, or by the need of going elsewhere for employment, are recognized and provided for by the building society. A repurchase is made *à l'aimable*, and to the greatest extent in the interest of the purchaser, who is considered to have been a simple renter, to whom his monthly advances of purchase-money are returned. This liberal policy partakes of the wisdom of the whole management of the company, which may be commended to particular study, as set forth by Mons. Veron. Holdings under such a company, which are not unconditional even when the purchases are completed, are very distinct from perfectly individual proprietorships. As a rule, a poor man makes a poor landlord, and for his family a bad one; and it would be better for them to be under a rich one. The family of the poor man have to submit to discomforts from dilapidations, without the power of freeing themselves by any change from him. Moreover, I have never hitherto met with an instance of any structural improvement or advance in the dwellings of the wage class or peasant proprietary made by themselves. There is, however, one conspicuous and interesting example presented by the present Exhibition. In respect to the general economical policy of the wage classes, which is applicable to peasant proprietary of land as well as houses, when a man of this class can rent his land, as he commonly may in England at $3\frac{1}{4}$ or $3\frac{1}{2}$ per cent., or if he can rent his house at 5 per cent., it will be better for him to place his money in any insured investment for an equivalent or a better amount, as it will leave him free to change his market for his services or his savings. The peasant proprietor who holds his own lands at little more than 3 per cent., might, by purchasing manure or stock with his capital, get 10 per cent. or more.

The Emperor's plan.

His Majesty the Emperor, in his continued interest in the question of the improvement of the dwellings of the wage classes, about two years ago directed some new dwellings to be built, as is stated, on a plan of his own. They

are erected in the Avenue de la Bourdonnaye, in the Champ de Mars, not far from the Exhibition building. They are on the following general plan:—




SKETCH PLAN OF THE EMPEROR'S HOUSES IN EXHIBITION.

This plan was the result of his individual attention, and he maintained it against some objections offered to it, in a block of 41 more dwellings for the wages class (in the Avenue Dumesnil, near the Bois de Vincennes), but with a very important change in the principle of the wall construction, to be hereafter described.

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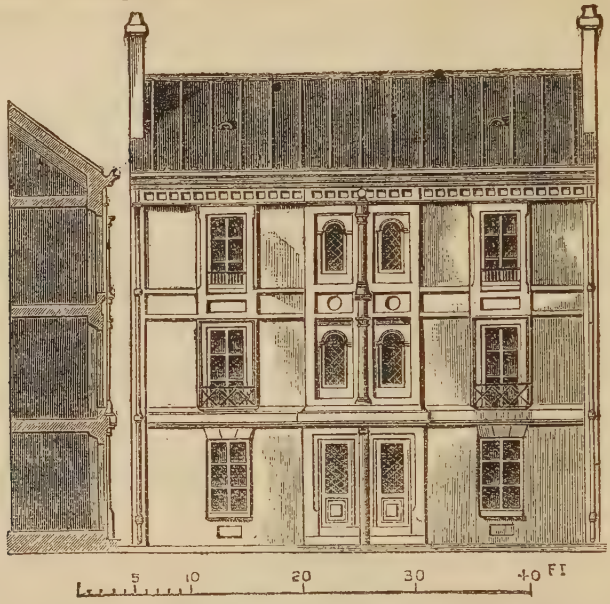
The following is the elevation of these dwellings:—

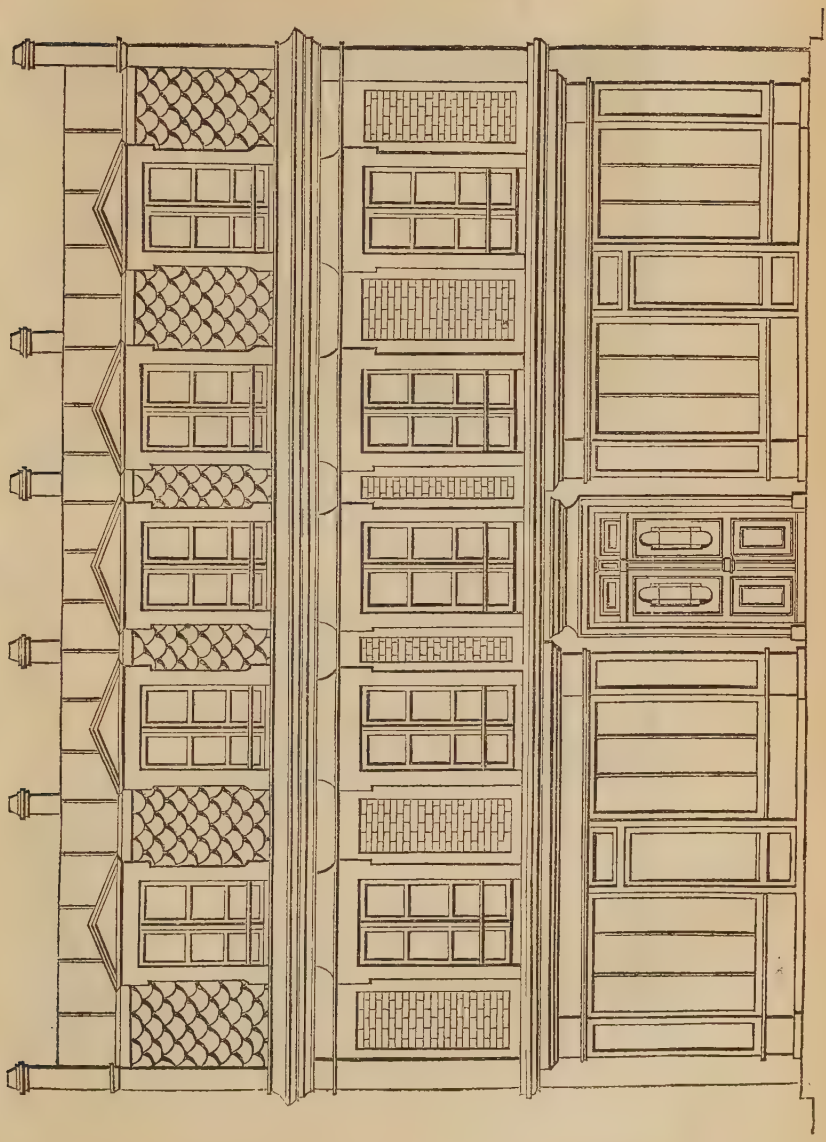



I went over the occupied buildings with some of the international jury, and I requested that the experience and feelings of the occupying housewives might be consulted as to the dwellings; and they were consulted separately, when they were found to be in unanimous and passionate disagreement with His Majesty's arrangement of the rooms. They complained, that he had so arranged the rooms, that they had always to go through the bedroom to the kitchen, where they have their principal occupation. Perhaps the mistake arose from following the common English arrangement, which is to place the *scullery* in the rear of the house, the cooking being done by the English housewife in the front living-room, at the common fire.

The plan of the workmen of Paris.

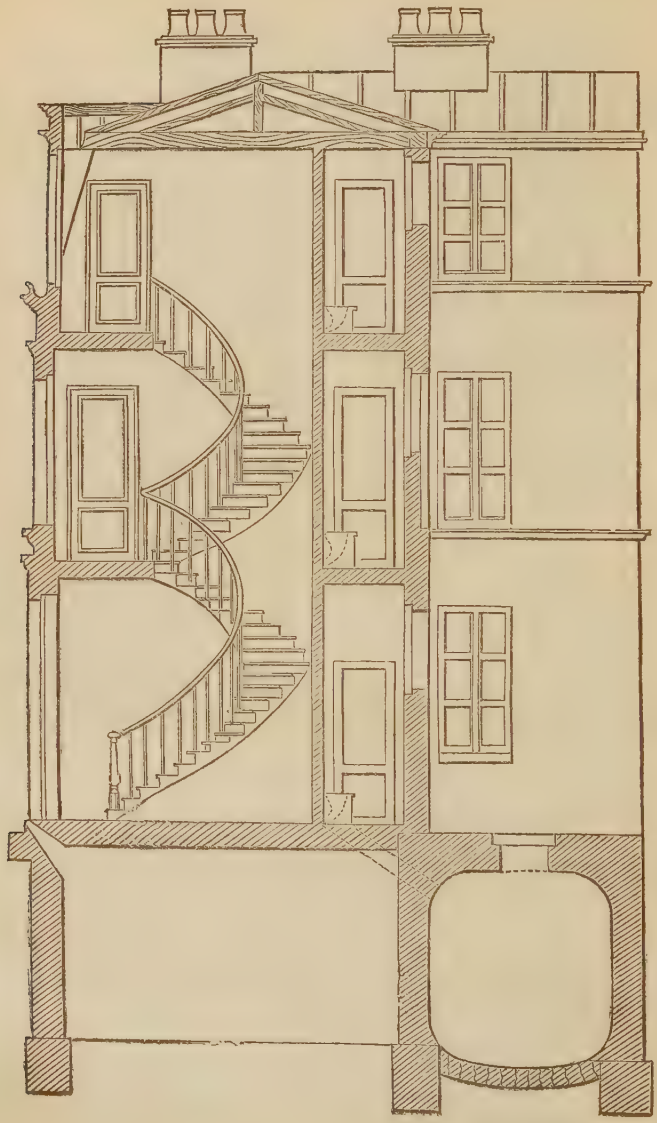
The associated workmen of Paris, whilst they bowed reverently to his judgment in the great arrangement of the position of States, yet ventured to assert their own in the position of their cuisine, and of the rooms in which they were to live, and declared that they could themselves make improvements in them—as they would show if they only had the money. Whereupon the Emperor benignly said they should have the money to show what best suited them, and granted them an allowance of 26,000f. to make their own trials, and the first result is the model dwelling of the workmen of Paris, which is constructed close by that of Mulhouse, within the Exhibition. We give the elevation of their building,

which they conspicuously proclaim is designed and constructed by themselves—*sans architecte et sans entrepreneur*;— MR. CHADWICK ON DWELLINGS.

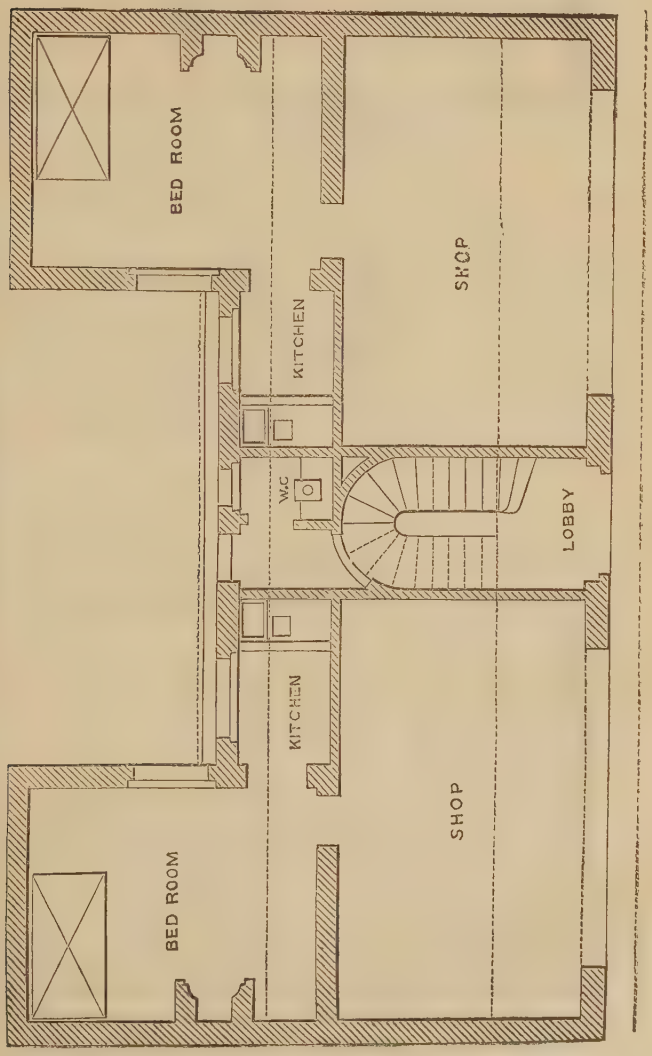


Elevation.

Section.

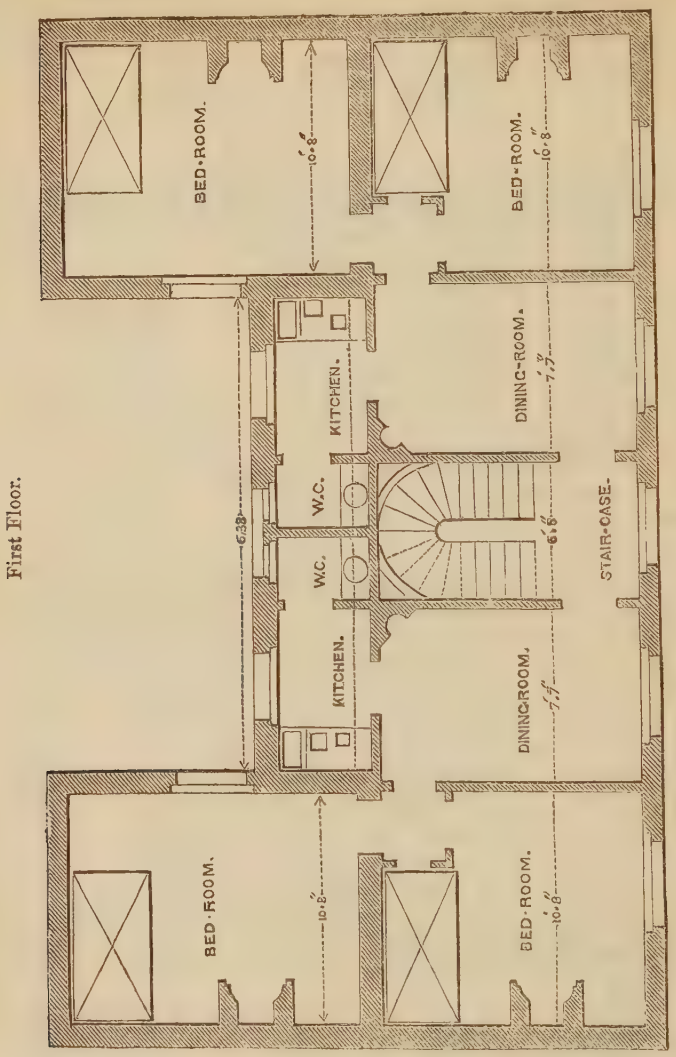


The following is their plan, in which it may be observed that they reverse the arrangement made by His Majesty, and place the cuisine in front of their dwelling.




Ground Floor.

MR. CHADWICK ON DWELLINGS.




On the whole this house, on examination, it will be agreed is, under the circumstances, a decided success. Some ventilation, though I deem it imperfect, is provided for the living and the sleeping rooms; but the window space is large. They have preserved an open ornamental grating for the front door, and the stair space is large; but with that front door aperture it will serve for aeration and contribute to make the whole house one which will be of good, or comparatively superior, aeration. The elevation is

cheerful and in good taste, and the papering and internal decoration (without saying that Mr. Owen Jones could not improve it) are superior to any real workman's efforts that I have seen in their dwellings in England. Allowing that the occupants of model dwellings in Paris, as well as with us, are mostly of the foremost of the wage classes, it was observed, in visiting a new set of model dwellings erected by Mdme. Jouffroy Renault, at the Rue de Cailloux, and others, that the style of the decoration, the large mirrors, and the taste of the pictures, as well as of much of the furniture, is greatly in advance of those in dwellings of the same class in England. Of its superior *batterie de cuisine* I shall make separate mention.

Workmen's preference of association with the upper classes.

The workmen in refusing, as I have stated, to be, as they expressed it, "caserné," had been influenced by a feeling of repugnance to being dissociated from the middle or other classes of society. I have observed similar feelings manifested in England, and I must submit that they are right. A cité ouvrière exclusively—a dead level of society—is not good for them. Their wives prefer to have high instead of exclusively low neighbours, and to see, and have their children see, what is going on about and above them. This feeling is also widely prevalent in England. The cottager's wife would prefer being near the Hall, or the Mansion, or the Parsonage, or to people of high rather than those of low degree. Cottagers' wives and children, occupying cottages in wastes or byeways, always lose in cleanliness, tidiness, and in other respects, by being out of the observation of "my lady," or of the clergyman's wife, or of the squire, or of the clergyman. Go where you will the occupiers of cottages in out-of-the-way places are of inferior social condition. It was observable that the wage class of Paris took up a position of advantage over the shopkeeper. It will be observed that the lower part of the dwelling of the ouvriers of Paris is laid out as shops. I gathered that this arrangement was of a policy entertained by the wage classes to associate themselves with the middle classes, or the shopkeepers; and to do this as associated owners or as landlords, and in that position to obtain in reduction of their own charges as rent somewhat out of the shopkeepers' profits. This would be to reverse the conditions which prevail in some parts of London and other certain districts, where the smaller and poorer shopkeepers reduce their own charges by letting out (reserving to themselves only a back room as a living-room) the upper parts of their houses in lodgings to artizans.

Prefer letting shops to shopkeepers.

Of the model dwellings in the Exhibition, as a type of numbers in actual occupation, one of the next is that of

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Japy Frères and Co., of Beaucourt, in the Upper Rhine. The firm of that name, who, it is stated, employ several thousand people in the manufacture of watches and of jewellery, following the example set by M. Dolfus and the manufacturers of Mulhouse, started an association for the construction of improved dwellings for their workpeople, and especially for their journeymen watchmakers. Their model dwelling is one on a distinct plan from that of Mulhouse, in being self-contained, and as containing a workshop.

Social advantages of detached dwellings.

Conceding the economical advantages of the four-tenemented houses at Mulhouse over the house rows or the street, I should yet advise to proprietors in rural districts the construction of completely detached dwellings as having considerable social advantage. For, the lower we descend in the social scale, the less is the self-restraint, the greater the passion and violence, and the greater the need of a certain extent of separation. In blocks of four contiguous houses, one morose owner, one shrew or "common scold," or one set of ill-conditioned children, from whom there is no power of escape, may render the habitation and the ownership of the other three almost valueless. I do not know how this may be or how it is provided against at Mulhouse. But experience in penal administration shows that too close aggregations of ill-trained people frequently work badly in England, and how important is the power of ejection and freedom of change of occupancy. A magistrate's clerk of great experience in the City of London once observed to me that in rebuilding a city the architect should for social reasons be prevented making close courts or alleys with common pumps. When the rooms in close places overlooked the opposite rooms, the female occupiers were apt to put about offensive tales and criticisms on what went on in each other's rooms, which ended in fierce quarrels and assaults. One or two common pumps almost kept two low attorneys, the sequence being this:—A little girl going to fetch water was thrust aside by a big girl, and being saucy was beaten by the big girl;—then the mother of the little girl came out and straightway beat the big girl;—then the mother of the big girl came out and straightway attacked the mother of the little girl;—then the husbands came forth to do battle for their wives and children, and then, usually with the Irish, sides were taken by the other occupiers of the court, and then there was a "battle royal"; then came prosecutions for assault before the magistrates, and work for the attorneys. One owner of a close square of buildings told me that he found it necessary to make two entrances to it, so that

people in feud might avoid meeting each other. Precautions are necessary to prevent people coming too close to each other, and jostling each other, for if they jostle each other they hate each other. I regret to say that according to my observation, in our own country, the great Christian precept "love thy neighbour as thyself," has yet to be made completely prevalent amongst people of high, as well as of low degree. As a minor illustration of too close contiguity, a proprietor stated to me that he found that he had made a great mistake in building cottages in rows with the doors contiguous to each other, as he observed the women in constant idle gossip with each other. This will be observed in streets with one side of the street with contiguous doors and the other with separate doors. Even in middle-class houses, the semi-detached, by which the speculative builder saves a wall and a yard of space between the two houses, are found to be productive of discomfort in other ways than the noise through the walls, of which hereafter; and higher rents are given for dwellings with the same internal space, but completely detached.

I pass by the single-chambered habitations, of which there are several types in the Exhibition; and also notice several of the remaining dwellings in the Exhibition as being cottages ornés, as little resembling the dwellings in question as opera shepherds do the veritable shepherds of the fields.

Public arrangements determining the internal sanitary conditions of dwellings.

There are sanitary as well as economical questions of construction connected with each type of dwellings, and questions of collateral and external public arrangement by which their external arrangements and conditions are modified. These questions—the wall question, the window question, the grate or the warming and cooking question, the chimney question, the ventilation question, the water-supply question, the house or cottage drainage question, as applicable to the dwellings of the wage classes—may each be best considered separately with the appliances for each displayed in the Exhibition.

## The Cottage-Wall Question.

The wall question.

Those who visit the common crowded dwellings of the wage class in our towns, even when they are unoccupied, are aware that the walls have a peculiar depressing, musty, or fœtid smell. On visits after severe epidemic attacks, in some of these dwellings a peculiarly offensive smell has been perceived, and on inquiry what that could pos-

Mr. Chadwick on Dwellings.

Foul walls.

sibly be from, the answer has been that it was the "dead man's smell," the dead body had been too long kept near the wall in a state of decomposition, before it could be removed for interment, and the fœtor inhered to the wall. In the course of the service, under the Public Health Act, when the occupiers were nearly all struck with fever, we have, in some cases, ordered all to be removed and the walls and ceilings to be limewashed. But it has occurred that the performance of this service has been obstructed or neglected with respect to particular houses, and in those uncleansed houses, and those alone, and with fresh occupants, the fever has broken out again, thus demonstrating the condition of the "leprous house" and the efficiency of the work of purification.* Walls lathed, plastered, and papered are even worse for such tenements. The laths rot, the size of the paper decomposes, and the paper itself harbours vermin. The condition of some houses of this construction is horrible. To admit of the cleansing of the walls by lime-washing in Miss Burdett Coutts's, in Mr. Peabody's, and in other

* The following extract exemplifies the cases that were of common occurrence under the Public Health Act:—"Shepherd's Court consists of about six "houses. It was notorious that fever had prevailed to a great extent in this "court; in the house in question several cases of fever had occurred in "succession. The house is small; contains four rooms, two on the ground "floor and two above; each of these rooms was let out to a separate family. "On the present occasion, in one of the rooms on the ground-floor there were "four persons ill of fever; in the other room, on the same floor, there were "at the same time three persons ill of fever, and in one of the upper rooms "there were also at the same time three persons ill of fever; in the fourth "room no one was ill at that time. It appeared that different families had in "succession occupied these rooms, and become affected with fever. On the "occasion in question all the sick were removed as soon as possible by the "interference of the parish officers. An order was made by the Board of "Guardians to take the case before the magistrates at Worship Street. The "magistrates at first refused to interfere, but the medical officer stated that "several cases of fever had occurred in succession in this particular house; "that one set of people had gone in, become ill with fever, and were re-"moved; that this had occurred several times, and that it was positively "known this house had been affected with fever for upwards of six weeks "before the present application was made. On hearing this the magistrate "sent for the owner of the house, and remonstrated with him for allowing "different sets of people to occupy the rooms without previously cleansing "and whitewashing them; telling him that he was committing a serious "offence in allowing the nuisance to continue. The magistrate further "gave the house in charge to the medical officer, authorizing him to see "all the rooms properly fumigated and otherwise thoroughly cleansed, and "said that if any persons entered the house before the medical officer said "that the place was fit to be inhabited, they would send an officer to turn "them out, or place an officer at the door to prevent their entrance. The "landlord became frightened, and allowed the house to be whitewashed, "fumigated, and thoroughly cleansed. Since this was done the rooms "had been occupied by a fresh set of people, but no case of fever has "occurred."

model dwellings, the walls have not been plastered or papered.* In some instances the sanitary orders are that the walls shall be limewashed twice, and in other instances as often as four washings a year are deemed necessary. The occupiers greatly dislike these bare brick walls. In new hospitals the evil is in a great measure prevented by

* French hygienists are strong in their denunciations of the mephitisme as also the damp of habitations. They state that the deleterious emanations from the body, discharged by respiration, and even by the sweat, even in perfect health, attach themselves to walls as well as clothes, "et plus parti- " culièrement aux pierres des murailles, à celles surtout qui sont de nature " poreuse ; la elles sont condensées et frais par l'humidité de la transpiration. " Les ventilateurs qui renouvellent l'air sont presque sans effet par rapport " au *mephitisme* des murs. Les *vapeurs* desinfectantes lavent bien l'atmo- " sphere des souillures dont elle est impregnée, mais l'infection des murs " échappe en général leur action." There have hitherto been no satisfactory analyses of this mephitisme, but "Quoi qu'il en soit de ces explications " il est certain qu'il existe suivant l'energique et pittoresque expression de " Moïse, *lepra domorum*, une lèpre des maisons, une lèpre des murs, qui, si " elle ne va pas jusqu'à les ronger, n'en est pas moins funeste, au point de vue " de la salubrité. Le méphitisme des murs résulté de l'accumulation de " l'infiltration, des miasmes à la surface, et dans les interstices des pierres " du mortier du plâtre, etc. etc. Il s'y forme, pour ainsi dire, des nids de " miasme, qui sont des foyers d'infection, et qui agissent comme un poison " spécial sur la crasse du sang. Une fois qu'ils ont pris droit de domicile, " pour ainsi dire, ils persistent avec une opiniâtreté vraiment fabuleuse. Nous " citerons des exemples à l'appui. Sous le ministère de Lamoignon de " Malesherbes, le donjon de Vincennes, cessa d'être prison d'Etat. Plusieurs " années après leur mise en liberté d'anciens détenus retourneront visiter " les lieux qui les avaient renfermés ; ils furent frappés d'y appercevoir " absolument la même odeur que celle qui regnait dans leur captivité. Un " médecin, Sainte-Marie, donnait des soins à une personne atteinte d'une " affection gangréneuse à laquelle elle succomba. Deux ans après, étant re- " tourné dans la même place visiter un autre malade, il retrouva la même " odeur gangréneuse, l'odeur *sui generis*. Il y a quelques années, à Lyon, " dans une des salles de la Charité, sevissait une épidemie de fièvre puer- " pérale très menstrien. Quinze ou dix-huit femmes recemment accouchées " succombèrent dans l'espace de quelques jours ; l'administration s'en émut, " on évacua la salle, et on y mit des ouvriers pour la nettoyer. A mesure " qu'ils détachaient le plâtre des murs et du plafond, c'était une odeur des plus " fétides qui se répandait. Nous avons entendu le Docteur Polinière, admi- " nistrateur des hospices, raconter que l'infection était si grande qu'elle " l'emportait même sur celle d'un amphithéâtre de dissection. Une fois la " salle appropriée l'epidémie s'arrêta. D'après ce que nous venons de dire, " les inductions sont faciles à tirer ; il faut, nous le répétons, pour détruire les " miasmes qui causent le méphitisme des murs et des plafonds dans les " hôpitaux, les chambres particulières, les alcoves de détacher à certaines " époques les veilles couchés de mortier et de plâtre, changer même les pierres " vermoulues, suivant la recommendation du legislateur Lébrun. Ces me- " sures seront très importantes à prendre ; on le comprend dans une pièce, " on aura séjourné longtemps un malade affecté de phthisie, de dissenterie, de " cancer, de gangrene, ou de toute autres maladies chroniques infectantes." " Dans les grandes villes, et surtout dans les anciennes quartiers, le méphi- " tisme est endemique, chacun peut le reconnaître." ("Devey, Hygiène de " Famille," p. 401). In this work of cleansing the hospital walls in England, where the work has been delayed, in several instances every workman engaged in it has been made ill.

MR. CHADWICK ON DWELLINGS.

facing the interior wall with some hard and smooth surface, generally of the best non-absorbent and washable cement. As a principle, all interior cottage walls should be made washable. Besides the evil arising from absorbency of the animalised gases by walls of the common construction, there is another great source of evil attaching to walls of the common brick and the common soft stone construction—the absorbency and retentiveness of water or damp. In England, the common bricks absorb as much as a pint or a pound of water. Supposing the external walls of an ordinary cottage to be one brick thick, and to consist of 12,000 bricks, they will be capable of holding 1,500 gallons, or $6\frac{1}{2}$ tons of water when saturated. To evaporate this amount of water would require nearly a ton of coal, well applied. The softer and more workable stones are of various degrees of absorbency, and are often more retentive of moisture than common brick. Professor Ansted states that the facility with which sandstone absorbs water is illustrated by the quantity it contains both in its ordinary state and when saturated. He states that even granite always contains a certain per-centage of water, and in the dry state is rarely without a pint and a half in every cubic foot. Sandstone, however, even that deemed fit for building purposes, may contain half a gallon per cubic foot, and loose sand at least two gallons. When water presents itself in any part of such material it readily diffuses itself by the power of capillary attraction, by which, it is observed on some walls in Paris, it ascends 32 feet from the foundations. Walls of such absorbent constructions are subject to rising wet by capillary attraction, as well as to the driving wet of rain or storm. To guard against the driving wet on the coast expensive external coverings, "weather slate," are used. But these do not stay the interior rising wet. This wet, having to be evaporated, lowers temperature. Damp walls or houses cause rheumatism, lower strength, and expose the system to other passing causes of disease.

Damp walls.

Extent of damp in stone as well as in bricks.

In London it is admitted that houses, even of the better class, cannot safely be inhabited in less than nine months. Indeed, registrars of deaths are aware that an extra death rate is, after all, usually attendant on their first occupation. The majority of bent figures in our villages are due to the infliction of rheumatism from damp.

An experienced traveller in England laid down a rule to avoid bedrooms with northern aspects, which, having less sun upon them, were, when unoccupied, the most damp, and if the bed touched the wall there was the most danger of a damp bed. To keep out the damp an extra quantity

of fuel is necessary; the evil is the greater with the poor who are often obliged to leave their rooms without the fires which the more wealthy are enabled to have kept up.

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In Paris, notwithstanding its particularly dry subsoil and its drier climate, the sanitary, or insanitary, evils of the common architect's constructions appear to be even greater than in London. I was assured by a Parisian builder of considerable experience that it was unsafe to occupy any new house in Paris in less than a year after its construction, and that there were houses in Paris which would never be dry "in their lives," and would always afflict their occupants. In going over the new model dwellings constructed for the Emperor we observed marks of damp upon some of the walls, though they had been erected nearly two years. The concierge who showed them to us was suffering from a grievous rheumatic affection; and I was informed that the occupants had had much illness amongst them from having occupied the houses "too soon."

Danger of the occupation of new houses.

Complaints, I found, were made in another set of the model dwellings, to which the jury had proposed to accord a medal, of the inferior quality of the tile pavement of the rooms. And certainly the common tile or brick floorings—especially absorbent tiles and tiles which conduct heat rapidly, as some of them do—are detrimental to strength. A cook, who suited her master, an eminent manufacturer, gave him notice to quit, as she found that she could not work so well, or without detriment to health, on the brick or tile floor of his kitchen as she had done in a kitchen with a wooden floor. He found that a number of his female workers made the like complaints of the bad influence of common tile floors. He could not be persuaded of these different results; and, to try them, he had a wooden floor laid down in part over a tile floor, so as to enable him to walk up and down for a length of time, with one leg on the tile and the other on the wood, when he found that the leg on the tile floor sooner become cold and tired; and he was convinced. He had a wooden floor laid down in his manufactory, and his benevolence was rewarded, and his expenditure repaid by more steady, longer, and better work from his people. If the tile, however, be of good quality, dense, and non-conducting, or if the floor be hollow and warmed, which would be practicable in large buildings, the conditions are altered in favour of tile floors.

Damp or cold room floors.

In one set of model cottages, to which a prize had been awarded (for advances on other points), complaint was made to me by the housewife of another set of inconveniences to

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which the common absorbent and permeable wall constructions are exposed, and that is, that, although they are comparatively thick, they are permeable in a high degree to sound, as well as to damp and the mephitic gases. The housewife stated that as they lay in their bed they could hear through the wall what was said in the bed room of the next house. In consequence of this annoyance they paid an extra rent for an end house, in which the inconvenience would be confined to one side. These sorts of constructions, generate angry passions and inflict much misery, as a person of feeble health and susceptible nerves of another condition of society might appreciate by taking up his abode in such a dwelling.

Hollow brick drier than solid brick.

In view of the first class of evils of insanitary condition, those of absorbence of damp and miasma, it occurred to me some years ago that an improved brick would be the preventative, if it were made hard and non-absorbent. But this it could not, with many clays, if it were made thick or solid. To get the London clays or other clay to dry without cracking they are mixed with breeze or cinders, by which they are made spongy. It appeared to me that the drain-tile making machine, which produced cylindrical forms so rapidly and cheaply, might turn out equally well rectangular forms or hollow bricks, which, having less clay in them, would absorb less moisture, and might, indeed, be burnt hard and made impermeable. The first machine-made hollow brick ever made, as far as I am aware, was made at my instance by my friend, Lord Fortescue, with his tile machine, and used in 1847 for the construction of some of his new cottages. Lord Shaftesbury also had some made and used, undoubtedly with the advantages contemplated of increased dryness and warmth. Subsequently I submitted the plans of cottages with hollow impermeable brick walls to his Royal Highness Prince Albert, who considered and approved the principle of the impermeable and washable wall, and applied it for his model cottages in forms varied from those I had suggested, but with glazed, impermeable, and washable interior wall-faces.

It is this important and established sanitary principle of construction which appears to have been overlooked, and that there is a falling off displayed in all the model dwellings. None of them have a washable wall. All in due time will have a musty smell, and be infested with vermin, which, I am informed, is frightfully the case with the houses of the wage classes in Paris. It is the fact, however, that in several of the wall constructions in the Exhibition there is an advanced application of hollow brick;

instead of lath and plaster dividing walls they have improved hollow-brick walls, which are economical, less sonorous than the old walling, and answer very well; but their facing is of porous plaster, papered. In the annexe of class 65, of materials of architecture, will be found examples of hollow brick in common use for walling beyond any that have yet got into common use in England, though not in advance of scattered examples to be found there. The further improvement which the French bricks require is in the qualities of greater density, greater non-absorbency, which it is found may be imparted to them by an improved machinery at an inconsiderable extra expense. If the sanitary knowledge were wide and the appreciation of the importance of the sanitary qualities and the demand were extensive, smooth and coloured brick or tile surfaces might be produced on large scales at rates that would render them available, at prices no greater than papered or coloured walling. The best specimen of a sanitary wall-surface, as I deem it, will be found in class 24 of the Prussian department of the Exhibition, in the white pottery, large exterior surfaces covering stoves, manufactured by T. C. F. Feilner, of Berlin. In them the joints are almost imperceptible. I am assured by Mr. Scrivener, the engineer of the potteries, that by machinery, if there were a sufficient demand, ornamental terra-cotta or impermeable tile surfaces may be produced at a charge below that of unhewn stone for architectural constructions.

Cost of pottery as compared with stone.

I have stated that the best sanitary construction of a house, apart from any question of cost, would be on the principle of the Crystal Palace, only with thick slabs of opaque glass, and with double walls, inclosing (like double windows) a still air, which would be the best means of meeting external variations of heat and cold and preventing the evils of the interior absorption of moisture or of miasma. These impermeable walls should, however, be accompanied by improved means of ventilation, of which hereafter.

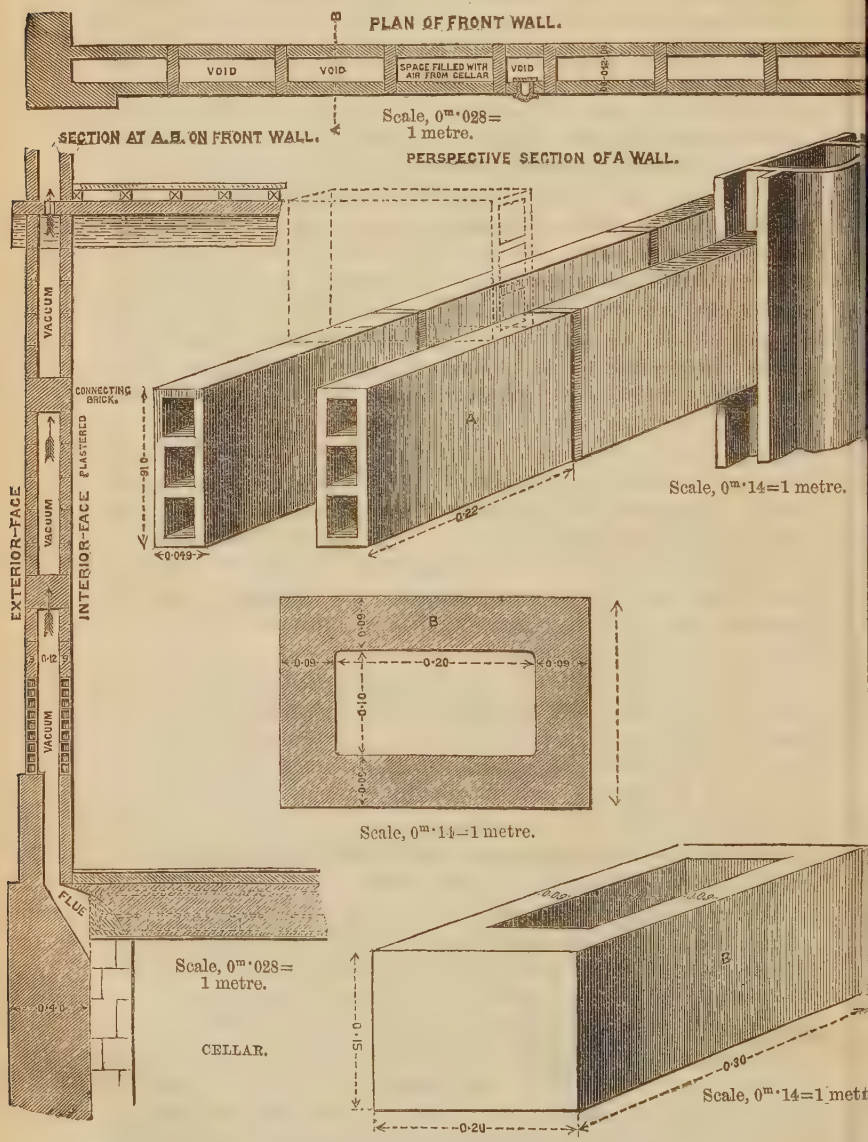
The chief and the important novelty in construction in the Exhibition is in the model dwelling of the co-operative society of Paris, made by Mons. Stanislas Ferrand, the architect, to some extent on the principle I have stated.

He constructs his walls of hollow brick, and makes the wall double, thus:—The thickness of the double wall is 5 in., which, of course, would be insufficient for bearing purposes. But the wall is held together, and the bearing power is obtained, on what I have termed the Crystal Palace principle, by iron columns, beams, and cross-trees.

Double hollow brick wall.

MR. CHADWICK ON DWELLINGS.

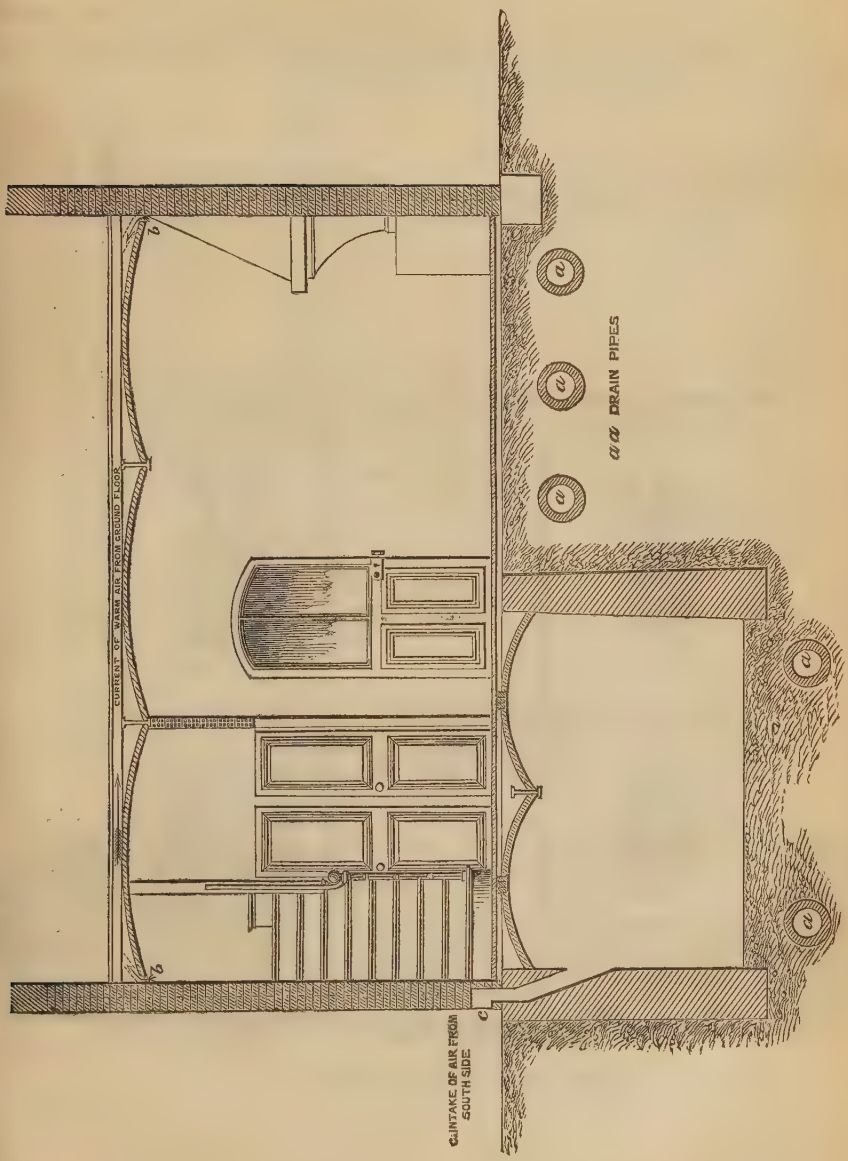
The following plans and cross sections display the principles of his constructions, which appear to me to be deserving of attentive study :—




A. Ordinary brick 0m. 22c. × 0m. 15c. × 0m. 045c. Price per 1,000 in Paris, 70 francs.

B. Bricks, Ferrand's system, forming the thickness of the wall, 0m. 30c. × 0m. 20c. × 0m. 15 Price per 1,000, 100 francs.

The following is the cross section, which further displays the principle of construction:—




*bb.* Valves establishing communication of hot air under the flooring of the first floor.

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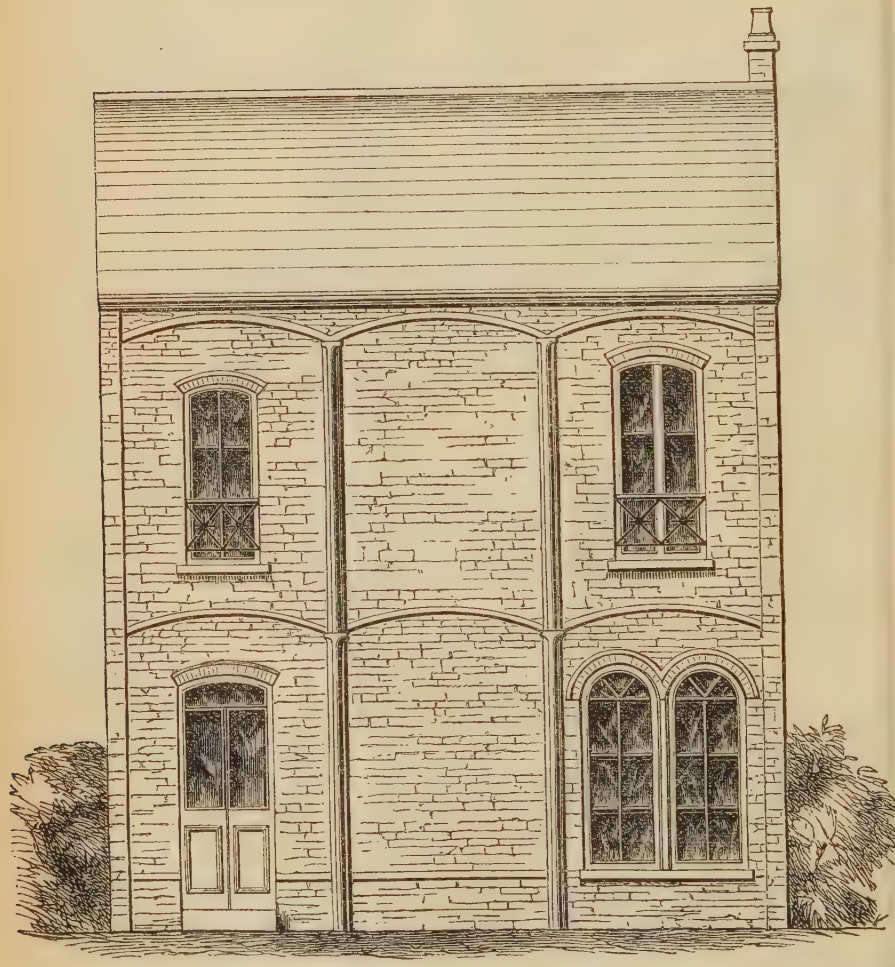
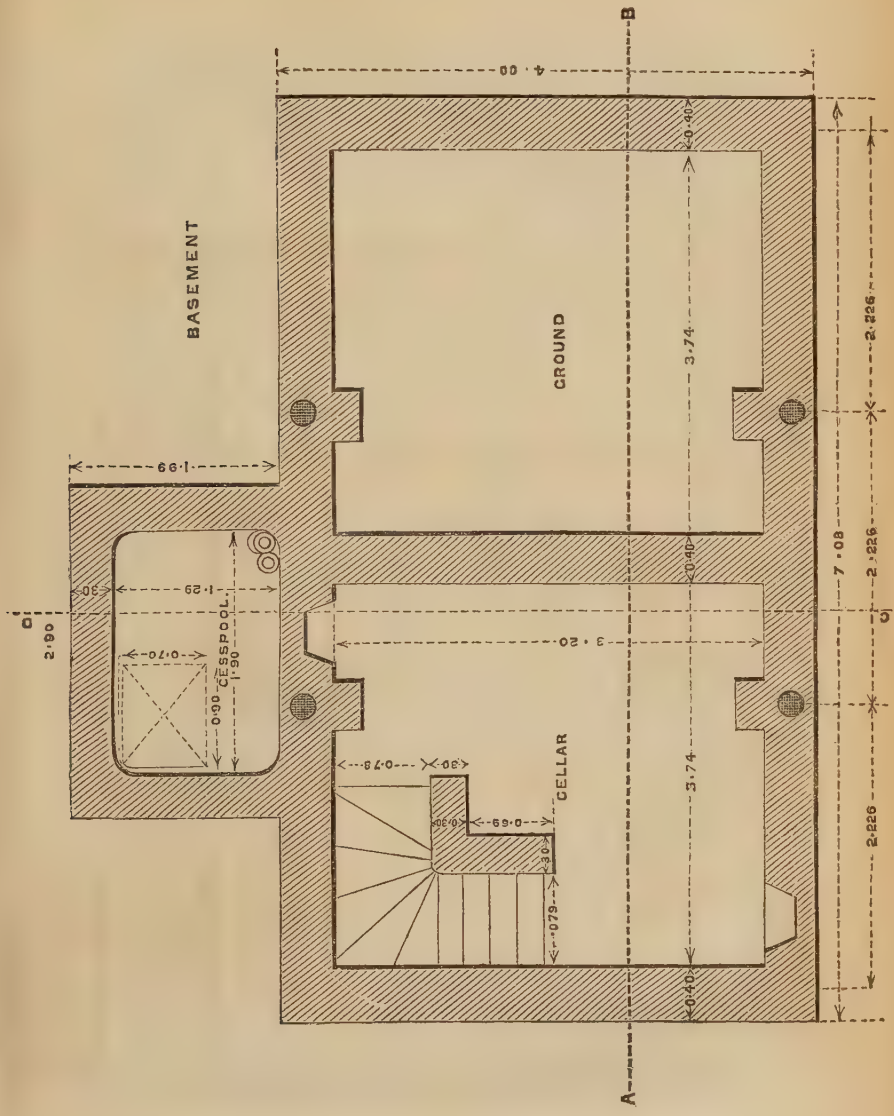
The following is the elevation, with the plans of the cellar, and lower and upper floor :—

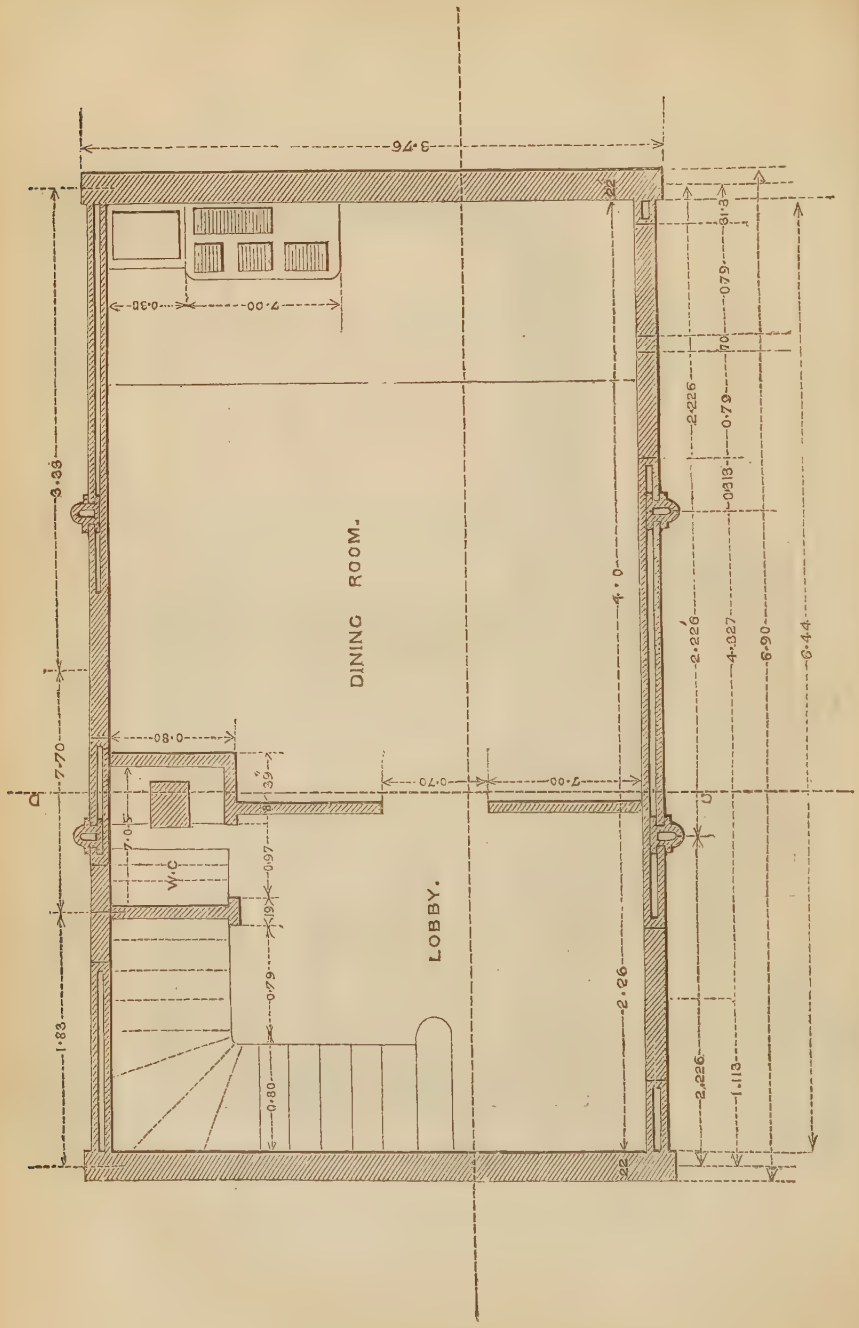
ELEVATION.



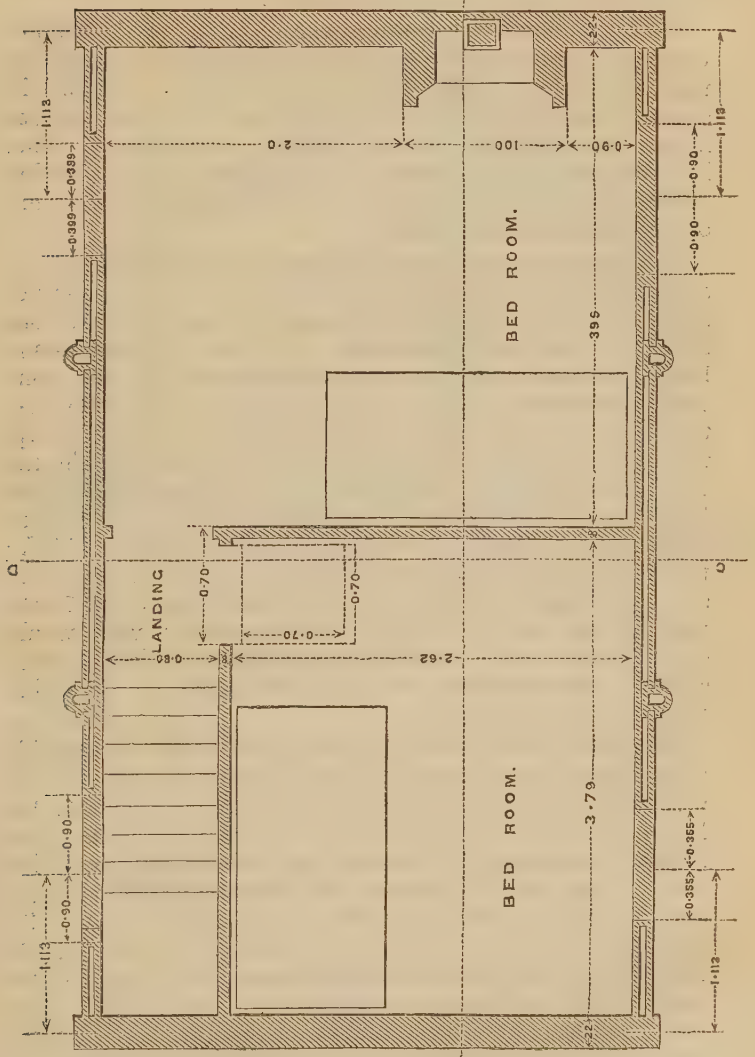
Scale, $0^{m}\cdot013$ to 1 metre (or, about 2″ to 1 foot).


B
4·00
0·40
BASEMENT
GROUND
3·74
2·226
1·99
1·29
30
2·90
C
0·70
0·90
CESSPOOL
1·90
3·20
7·08
2·226
0·78
30
CELLAR
0·69
0·30
0·79
3·74
2·226
0·40
A

GROUND FLOOR.



FIRST FLOOR.


BED ROOM.
BED ROOM.
LANDING
2·0
1·00
0·60
3·95
3·79
2·62
0·70
0·70
0·70
0·60
0·90
0·90
0·90
0·90
0·355
0·355
0·399
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1·113
1·113
1·113
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2
C
C

MR. CHADWICK ON DWELLINGS.

He claims for this construction the advantages of walls which are thin, and which therefore save space, and yet are warmer, resist changes of temperature better, and are better non-conductors of sound than the common brick or stone bearing-walls, and that at a lower cost.

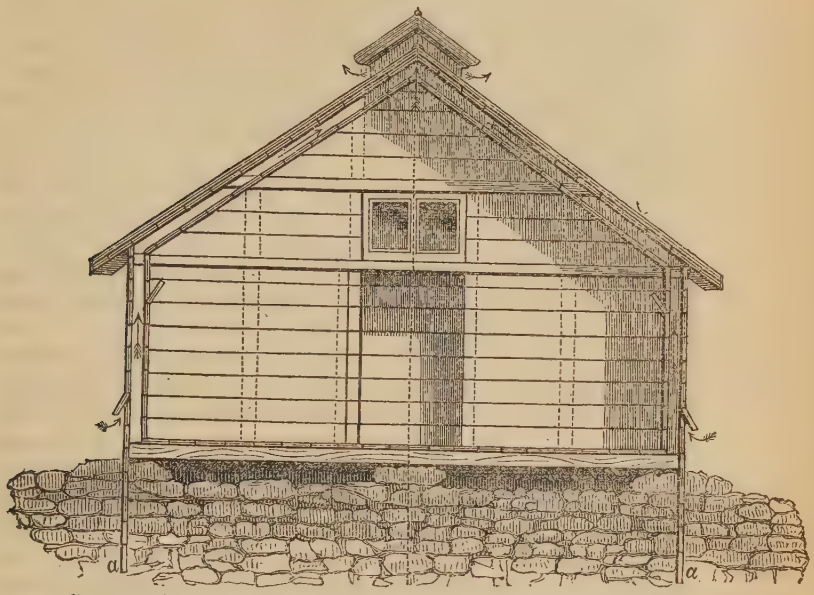
Of the hollow-brick cottage constructions, with hollow-brick flat roofs as well as walls, in England, it is reported that, as anticipated, they are warmer in winter and cooler in summer than the common constructions; whilst of ancient hollow floors that are warmed by hot air underneath them, it is declared that the warmth derived from their extended surface is more comfortable than that derived from any other mode of house-warming.

Of the superior quality of the wall itself, of its advantage as a non-conductor of heat and of sound, of its economy of space, and of the general advantage of this iron-tied construction, there can be no doubt. If it were of our common brick construction, the expense of a dwelling of the same size, constructed in the cheapest manner, would not be less than 150*l.* I have an estimate from Mr. Samuel Sharp, the architect to whom I am indebted for assistance in the drawings and the technical points of this report, that on a large scale the improved iron-tied double wall detached dwelling might be constructed in England for about 110*l.*; that is to say, if the construction were on a large scale, and as a manufacture. Moreover, the substitution of the 5-inch wall for the common brick 14-inch cottage wall would ensure a gain of 710 cubic feet of space, which, as such space is now allotted in cottages, would serve as breathing space for two people.

The principle of this construction is to obtain an equable temperature by the couch of air between the two hollow walls. It may be observed in the plan that the space between the walls opens into the cave beneath. The space there it is assumed is usually kept unoccupied, and that the air there is of the medium underground temperature,—cooler in the extreme heat of summer, and warmer in the extreme cold of winter than the outer air. By openings in the upper rooms, the interior wall space may have a circulation of air to serve for ventilation. But in still air a very small amount of heat, a jet of gas, will keep the interior wall space and the floor (if the hollow brick construction be extended to the floor), agreeably warm in winter.

The principle of the hollow wall construction has been tried in the construction of hospital huts in the tropics, and

is reported to work well. The following is a cross section of one of them as given in the report of the Army Sanitary Commissioners. MR. CHADWICK ON DWELLINGS.




Cross Section showing ventilation under the floor, and up the side and roof.
*a* Holding-down bolts.

The huts have been constructed of ordinary scantling, and it is reported of them that their temperature during very hot weather has not been higher than the air outside in the shade, and that during a rigorous winter they were sufficiently warm; whilst the air within was always pure, even during hot weather. This experience is entirely confirmatory of the independent theory of Mons. Ferrand, which is of very great importance for application in India and the tropics generally.

Though the principle of hollow wall construction was new to us it was well known to the Romans, as is shown in Vitruvius, and was in extensive use amongst them, as shown by their remains. Wheresoever damp was to be arrested, they had recourse to hollow tile walls. Their principle of warming hollow floors would be of great value for block buildings occupied by the poor, and also for school rooms. Warmth applied from such a medium to the feet is most economically applied to the body, and it induces throwing open windows, and a freer ventilation by the people. Advantages of warming hollow floors.

Mr. Chadwick on Dwellings.

The hollow brick iron-tied roofs that have been recently introduced into this country are proved to be cool in summer and warm in winter, and at the same time of a cheaper construction than the common pitched timber and slate roofs, the experience of which is the reverse, the slates being sometimes so hot in summer that it is found necessary to whiten them, whilst they are excessively cold in winter.

Of the double hollow wall it is to be observed that the outer wall serves in a superior manner the purpose of "weather slating."

Inconvenience was apprehended from the quality of expansion and contraction of the iron supports and ties with variations of temperature, but although there are various methods of meeting it, M. Ferrand assured me that hitherto no inconvenience has really been experienced from it, at all events in these smaller houses.

Instead of facing the wall with soft plaster and paper, a non-absorbent and washable surface might be used. M. Ferrand's attention having been directed to that desideratum, he has invented a new wall surface, the specimens of which I saw were almost as white as alabaster, and washable. He expected that such a surface might be obtained at about a shilling a yard.

With this fine impermeable wall surface the whole construction would be one of very great improvement in sanitary quality, as I was glad to be assured, without any increase of expense, or even with a reduction of expense, as compared with our common brick constructions.

On the whole, Mr. Ferrand's model is eminently worthy of consideration as being an advance in the principle of construction, and as affording the best promise of any in the Exhibition in connexion with the sanitary improvement of the dwellings of the general population.

Tile wall construction.

Some years ago Mr. Semper, the architect of Dresden, entered into the consideration of the wall question, and prepared a plan of construction of tiles with lock joints instead of hollow bricks. These tiles were to be used in pannels between iron supports. The advantages promised from this tile construction were, that the tiles would pack closer in kilns, and might be made and transported more cheaply; that a finer species of tile might be used for the inner wall surface, and of different colours. The promise for ornamental constructions was very high indeed; but the difficulty was then, as it is now with terra cotta, to get perfect exactitude in form of joints as well as surface without enormous additional expense. Subsequently a

means of obtaining the desideratum, perfect exactitude of form in the construction of earthenware pipes for house drains and sewers. At my suggestion of the desideratum Messrs. Burton constructed a machine which applied great mechanical pressure to the pipes whilst the clay was only so partially dried as not to have entirely lost its plasticity. This second pressure corrected the twist given to the pipes in drying, and produced very complete accuracy of form, and increased very considerably the strength and impermeability of the stoneware. The principle of the second pressure by the machine was proved to be equally applicable and successful with rectangular forms, with hollow brick, and also with tiles, and that at an inconsiderable expense, for bricks of the common size not more than 1*s.* 6*d.* or 2*s.* per 1,000. But at the time there was no trade demand for exactitude in form, and the important improvement has yet to be brought into use. Neither tiles nor hollow bricks are confined to the square or usual form, and they may be made in sexagons or in polygons; the interior and exterior tiles, not necessarily glazed, may be of different colours; and if the manufacture be on a large scale, the price may compete with the common stone and brick. The exactitude of form so much prized by architects may be more readily obtained with tiles than with hollow brick. Houses of the impermeable tile construction may be put up with great rapidity and used for occupation immediately.

Besides the sanitary improvement of the impermeable and washable interior glazed brick wall of the model cottage of 1851, there are other long-tried and proved improvements in construction in England, which nevertheless have not got into extended use. There are various practical reasons for this. In the first place, they are little known to private individuals, and the common builders only attend to general demands; and any improvements requiring new forms which need care or study in alterations and adaptations for which there is no general demand can only be executed at increased expense to the first individual who adopts them. The common builder rarely feels any interest in changes, and is usually prejudiced against them, as requiring a change of habits in construction.

Besides these trade obstacles to amendment, there have been experienced serious obstacles from the trades unions to improved constructions of hollow brick. If the hollow brick be made of the usual size, the gain is chiefly in the quality of the brick, and there is little advantage in the price of the manufacture. But there is much gain if the cubic con-

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tents be enlarged; and a plan and estimate of a cottage, which I directed to be prepared for the Prince Consort, was submitted to the late Mr. Thomas Cubitt, the eminent builder and contractor, with walls of hollow brick, each of the size of twelve of the common bricks, and the 9-inch wall set in cement, costing 3*s.* the superficial yard, against 4*s.* 6*d.* and 5*s.* for the common brick wall set in mortar; the whole cottage, with improved qualities and washable walls costing 25 per cent. less than the common brick construction. The contractor admitted the correctness of the estimates, but he declined to adopt the new construction, and gave to me his reasons, to this effect:—"If I adopt that new and large "form of brick, which requires the use of both hands to set "it, my men will strike, and I shall have all the labour of "overcoming resistance; and when I have done it, and "shown how much more cheaply the construction may be "made, others will follow me, and I shall have no profit and "nothing but trouble and vexation for my labour. I will "not, therefore, undertake it." In other instances of the introduction, not of hollow brick of new sizes, but of machine-made brick of the common size, but consolidated and improved by pressure, the trades unions, at the instance of the brickmakers, have combined to prevent them; and thus one section of the wage classes have been blindly led to oppose most important improvements in the dwellings and the health and comfort of the whole of the wage classes.

Trade obstructions to sanitary improvements in wall construction.

There is, however, one important material, of which extended adaptations from all parts of Europe are displayed in the Exhibition—namely, Portland cements, in various forms of concretes, that appears to present great and earlier facility of individual use, with the least amount of skilled labour.

Concrete wall constructions.

My attention was particularly directed by the late lamented Captain Fowke to concretes, as a means of advance in quality as well as economy in labouring-class dwellings. He used much of it in constructions connected with the South Kensington Museum. An inferior specimen of it is presented in a small entrance-lodge there. It is proved that with a proportion of from one-fifth to one-eighth of Portland cement to sand, gravel, or small stones, a wall may be made one-third stronger than common brickwork; or with concrete a wall may be made of equal strength with one-third the thickness of common-place brickwork, and of equal thickness, at about one-half the price. The common brick absorbs about 20 per cent. of water. The concrete wall does not absorb one-quarter that quantity, and takes about a fourth the

usual time in drying, and when made of the harder stone, and properly mixed, it may be said to be impermeable to wet. In the French Exhibition of building materials there is a very interesting collection of specimens of concrete from Vicat's cement (which is nearly the same as Portland), with table tops for wine taverns, of polished stone, held together, like mosaic work, by the cement; as well as stone for foot and road pavement, and blocks for walls. In the North German department, from the manufactory at Bonn, there are large tiles made of Portland cement, with coloured concrete facings, worth examining, as also some very good sculptured casts and objects of external decoration. But the chief development of the application of cement to concrete constructions is made by M. Coignet, who by machinery crushes stone into as fine a sand and powder as he can get it, and mixes the materials of lime and cement, and by pressure produces specimens of enormous strength; when powdered granite or porphyry is used, of strength approaching to that of the original stone. In the annexe near the pond, in the direction of the Pont de Jena, there is a school-house constructed by him, with statues of granite, porphyry, and other objects, specimens of the material. These various specimens go to prove that, if objects with the qualities of hard stone are required with repetitions of design, it will be more economical to break the stone into pieces and recast it in moulds with cement than to carve it. One of the most important specimens is the flat concrete roof and its wide span, proving the possibility of making the ceilings and roofs of houses as with one large slab of stone. The principle of construction established by these concretes is, that everything is made as it were a monolith. A church at Vesinet, near Paris, is made of the Beton Coignet, and the steeple may be said to be a monolith. In inferior constructions this is of importance, as cisterns and large water-tanks are made of it, as in one piece, without the insecurity of numerous mere common mortar-joints. The proportions of the common beton, or concrete, were: of river-sand, of good quality, 5 cubic metres; hydraulic lime, slaked in powder, 1 cubic metre; heavy Paris cement (considered equal to Portland cement), 250 kilogrammes. I went over a house which had been built of the Coignet's concrete, more than twelve years ago, and it appeared to have stood frost and weather satisfactorily, and some chimney flues of concrete appeared to stand heat and soot very well. In 1848 I got some trial works made for the use of concrete for public drainage and sewerage work. I do not know what cement was used, but as cements were at that time less

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understood, probably the wrong sort was used, for the report was unfavourable. Subsequently large quantities of Portland cement have been used for the Thames Embankment; and Mr. John Grant, the engineer in charge of the works on the south side of the river, has made very extensive trials, stated in an interesting paper to be found in the *Transactions of the Institute of Engineers of London,* which establish the great strength of the material as about one-third greater than the commonplace brick of which cottages are constructed. The chief engineers of the city of Paris informed me that they have used large quantities of the Beton Coignet for sewers, for which, on account of its monolithic principle and evenness of surface, it is very advantageous; and that they were using it in the construction of bridges, and are well satisfied with it. I did not ascertain the various costs of production, but the price charged for this more finely manipulated concrete is less than for stone, though I did not perceive that in the class of dwellings in question it would have any material advantage in price over common brick; in sanitary qualities, however, it would have very great advantage indeed. It was averred that houses constructed of it, instead of being unsafe to occupy within a year, would be very safe to occupy within little more than a month.

Concrete constructions of the Emperor's new model dwellings.

But the Emperor has, on the advice of Mr. W. E. Newton, the English engineer, adopted for the 40 new dwellings of which I have already given the form, a concrete construction which will remedy almost entirely the common default of the damp walls of the first set of buildings erected by him, and give him the advantage over all the model dwellings in the Exhibition in economy and quality of wall construction except as to quality in the double hollow walls of the co-operative association.

The new wall construction is of Portland cement, one-eighth of cement to the gravel, sand, and stones to be got from the stratum of the foundations, and may be made without bricklayers or masons, and with common labour. Various forms of concrete walls—the cob walls and floors in Devonshire—are of old date; but there has been inconvenience in their construction, sometimes from deep troughs of the height of the story being necessary, but for the Emperor's new dwellings there was used a movable case, invented by Mr. Joseph Tall, with which the walls may be constructed very quickly to any height with considerable gain in time. The extent of the gain over old methods is, however, disputed, and it is alleged, that by a method

of making cob walls in use in Devonshire and Cornwall, about as good work may be produced by less expensive means. With one-eighth of Portland cement the cost of this construction in England, where there is fine sand or good gravel near the spot, is generally about one-half the price of brickwork; and as in small dwellings with much division-walling, more than half or nearly two-thirds of the entire cost of construction is in brickwork, this economy of half upon two-thirds is a very important gain, constituting often a turning-point of commercial advantage. Where improved model dwellings now yield 5½ per cent., as the average of the later buildings in the metropolis do, there is a great convenience of the concrete walling for distant places in this respect, that, inasmuch as the cement is only about one-eighth the weight of the mass of brickwork, there is only about one-eighth the cost of carriage, where brick is not to be had on the spot, and where there is loose stone, sand, and gravel, or clay that may be burned, and where there is common unskilled labour available. By putting in cylinders of zinc, and lining them with cement as the walls are carried up, and when completed taking them out, round and smooth chimneys, and water-spouts, and ventilation and warming flues may be formed readily, cheaply, and exactly. In respect to air-flues and spouting, the concrete construction appears to have the advantage over any of the other constructions that I found in the Exhibition, and to be readily available for much sanitary improvement. The concrete renders skirting-boards—those great harbours for vermin—unnecessary, and it runs all round the door and the window-frames, and therefore no filleting round them is required. The ceilings and roofs are made with concrete, for which Colonel Scott has invented a very economical iron framing. Of this concrete construction of ceilings and roofs, as well as of walls and stairs, there is little but the doors and window-frames to burn, and they may be said to be fire-proof.

Scott's cement.

The colour of the concrete wall of Portland cement is that of the darker stucco colour of houses in London, or of brown paper; which, however passable it may be for exterior surfaces, leaves improvement necessary in lightness and cheerfulness, even if the inner surface of the concrete wall be smooth. Colonel Scott, who succeeded Captain Fowke at the South Kensington Museum, and who has conducted extensive experiments on cements (stated in the *Transactions of the Royal Engineers*), and is deemed a leading authority on the subject, has invented one cement, which appears to be the desideratum for cheap wall-facing.

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It is a species of artificial gypsum, of a light warm colour, or of a light lime colour. When properly laid on it is stated to be as good as parian facings. It is hard, impermeable to wet, and it is, above all, washable. It has already been introduced for the lining of hospital wards, as possessing the requisite qualities. The expense of a facing with this cement, if properly used, is about two-thirds the expense of the ordinary three-coat work. Mr. B. Nicoll, of London, has adopted a new facing of magnesium, which admits of various cheerful colours, is non-absorbent and washable, and of very high promise at a low rate of charge.

Less thickness of walling required in concrete than in brick.

On the question of comparative economy of the concrete walling and the brick walling, it is assumed that the two walls are of equal thickness; but in the plans of model dwellings originally presented to the Prince Consort a construction was proposed on the panel or buttress principle, to economise material as well as space, the bearing power being supplied by the buttresses; and this may be given by 9-in. walling, with concrete, or in appropriate forms of hollow brick; and 4-in. or 5-in. walling of the right materials may serve for the necessary protection against the weather. 4½-in. walls of properly made hard hollow brick are proved to be better protection against weather in times of frost than 9-in. or 14-in. common brick or soft stone.

Nicoll's new concrete walling.

In the English exhibition of materials there is a new species of walling, invented by Mr. B. Nicoll, which presents very great advantage in non-absorbency of moisture, in non-conduction of heat, in having a washable internal facing, in saving space as against common brickwork, and being available at a much lower price. Over a framework of strong cross wires, of about an eighth of an inch thick, there is woven by a powerful machine a mass of straw or fibrous matter, which is saturated with a solution that renders it fireproof. It is then subjected to a very powerful pressure. A coating of light Scott's cement mixed with parian cement is then put upon it for inside facing, and of Portland cement for the outside facing. The surfaces are impermeable to moisture, smooth and washable with water, so as to save the expense of repeated lime-washings. It is formed into slabs in iron frames, which are put together and closely and securely fastened with bolts. The slabs are from 1½ in. to 4 in. thick. These slabs serve as superior panelling for dividing walls and partitions. Where space is of importance it has the advantage, perhaps, over concrete walling, in enabling a wall to be made of not more than 1½ in. or 2 in. in thickness, and yet its quality greatly deadens sound. It has also great advantages for weather-proof roofing superior

to slate or tile—though not, as I conceive, superior to well-made hollow brick (when it can be got), tied together with iron ties and covered with layers of asphalte and cement. In the Prince Consort's model the principle of the flat roof was adopted, but none of the model dwellings in the Exhibition have attained to that principle.

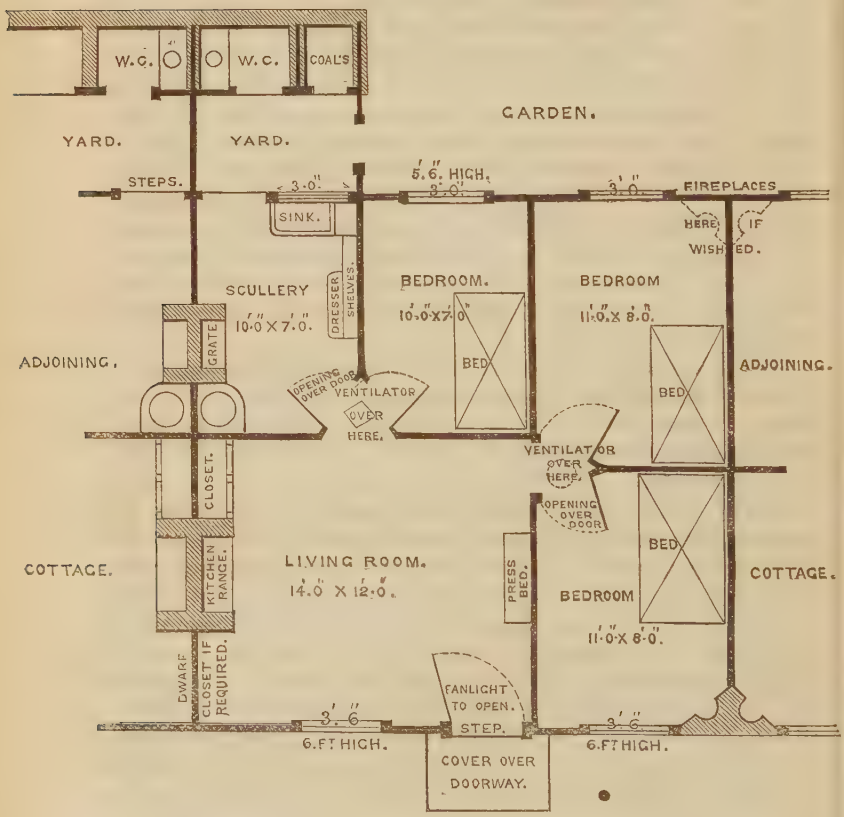
Where ground space is dear, as it is with the dwellings of the labouring classes in town, there is good reason for utilising the roof space. It serves as an additional drying-ground. In dry weather it may be used for the children to play on. One example has been set in London, where, in a densely crowded neighbourhood, there being no playground for a boy's school, they have made one for them on the flat roof. If anyone will look over the cité ouvrière of Mulhouse it will be seen what a large amount of roof space is lost; and yet the cost of the weather-tight flat roof of concrete or hollow brick is nearly a third less in England than the timber, slate, or tile roof. Its greatest convenience or use, however, would be for self-contained dwellings; on them the father of the family may sit in fine weather, and have better air and an extended prospect, and enjoy himself in the Oriental fashion.

In respect to the economy of these improved constructions, I have had trustworthy assurances that fully 24 per cent. of saving is obtainable, either on the hollow-brick principle, on the simple concrete principle, or on the Nicoll wall principle of construction. Mr. Samuel Sharp has made a very close estimate of a four-tenemented dwelling, on the principle of construction of the Prince Consort's model dwelling. At the present prices in England such a dwelling could not be constructed of brick for less than four hundred pounds, or a hundred pounds each separate dwelling. On the concrete principle of construction, with Nicoll dividing walls, it might be constructed for three hundred pounds, or seventy-five pounds each dwelling, minus the cost of land. Apart, however, from the superiority in quality, the improved dwellings would have a gain of cubic space. The cost of the chief dwellings and the space in them is as follows:—

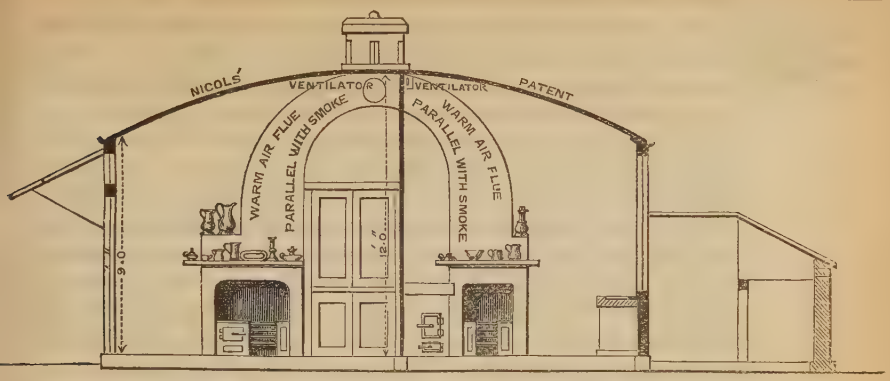
| | Total cubic space. | Cost per cubic foot. |
|---|---|---|
| The Mulhouse dwellings - - | 9,625 | 3 |
| The Workmen of Paris ditto - | 5,950 | $5\frac{1}{2}$ |
| The Co-operatives of Paris ditto - | 7,480 | 4 |
| Model dwellings (concrete) with washable interior walls, on the Prince Consort's principle of flat roofs - - - | 4,800 | 3 |

MR. CHADWICK ON DWELLINGS.

Mr. Sharp has prepared the following plan of a single storied cottage, which he estimates can be manufactured in numbers complete, for 60*l.* each, with grates, sinks, closets, and drains, all included.




SKETCH PLAN FOR A ONE STOREY COTTAGE BUILT AND COVERED WITH NICOLLS' SLABS.




SKETCH SECTION OF A COTTAGE COVERED WITH NICOLLS' SLABS.

ving of space over 9′ outside and 4½′ inside walls, 66 square feet floor space, 726 cubic feet air do.

| | | |
|---|---|---|
| Contains sitting or living room | - | 14′ 0″ × 12′ 0″ |
| „ 2 bed-rooms | - | 11′ 0″ × 8′ 0″ |
| „ 1 „ | - | 10′ 0″ × 7′ 0″ |
| „ Scullery, with sink, range, and copper. | | |
| „ Yard, with W.C. and coals. | | |

Parallel with the chimney flue is a ventilating flue, acting by the heat of the chimney, and made in concrete. The flooring is of wood laid in bitumen. A cottage of this construction has been erected near Wandsworth, and has stood one winter in a manner to offer the presumption that it will stand well for many winters. But it is expected that there will be other constructions of the kind shortly open to examination, from which a judgment will be formed of the great qualities they are warranted by Mr. Nicoll to attain,—namely, that they shall be damp proof, and have washable interior surfaces, that they shall be warm and vermin proof, and fire proof.

## The Cottage Window Question.

I need not state the sanitary importance of the utmost sunlight in climates like our own for this class of dwellings. It has been a frequent question put in Scotland, "Why do "you make those cottage windows so small now that the win-"dow tax is removed?" The answer is, "because if we "make them large in our severe climate the rooms will be "so cold in winter." It is commonly overlooked in respect to this class of dwelling how rapidly thin window glass radiates heat. I have had my attention directed to that on the question of warming union houses. As a rule, under the old constructions, about one-third of the warming power was, in cold weather, radiated through thin windows; but a

Waste of heat, by thin glass windows.

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double window with the stratum of air between, make the window space about equal to the common wall space in non-conducting power, and of very thick plate glass, approximate in proportion to its thickness to the double window. By one experiment in winter time it was found that the difference of radiation (the thermometer being at 30 deg.) between a thin window and one of thick plate glass is about 8 deg. To bring this home to the case of the labouring-class dwellings. If a man pays a shilling a week, as he generally does in London, for his coal for warming his one room in winter, one third, or fourpence of it, would be wasted through the thin window. Now this waste of heating power would compensate for getting a thick glass window or a double one. All the model dwelling windows in the Exhibition were of thin window-glass; some of them unnecessarily small panes, the woodwork of which would go far to provide thick glass and larger panes. The Austrian model dwellings, however, had a good double window, 6 ft. by 3½ ft., which I was told might be made for about 30f. Saving heat, as it would do, for a large proportion of the year, this window certainly would be economical. Windows made flush with the wall gain light as well as space. The Mulhouse and the model dwellings are defective in their window construction. There has been as yet no introduction into cottages of cheap forms of thick ground glass, which, without interrupting light, performed the service of curtains to the lower panes. Very thick glass is safer from breakage than thin glass; and therefore may be safely used in large panes, even for cottages. In some houses of a higher condition, in the north of England, plate glass is used of near ½ in. in thickness. It is so difficult to cut through, and requires a work of so much noise, that it is thought to render the use of outside shutters unnecessary; and only curtains are used to keep out light.

In the Mulhouse and other model cottages in the Exhibition I thought the outside shutters, particularly for the upper rooms, might be dispensed with, and the expense commuted into thicker glass, which had also the advantage in crowded neighbourhoods of adding to comfort by keeping out sound. Altogether this window question is one which calls for attention as a means of relief from the alternative of shutting out light to keep in heat in our colder climate, and for economy and health in the dwellings of the labouring classes.

### The Cottage-warming and Cooking Question.

In the condition stated of the cottager one-third of the heat of whose fire escapes through the thin window-glass in cold weather, the greater proportion or seven-eighths of the re-

mainder goes away up the chimney, unapplied, in all weathers. If the chimney be large, on the old plan, to enable it to be swept by climbing boys, and it has been left to cool, and get wet by rain, the ascending air is cooled, the smoke is not properly carried away, and the heavier coal gases of the inferior coals pervade the room. Entering inferior dwellings in our large towns, a stranger is commonly assailed by the cesspool smell, and the wall smell, compounded with smoke and the chimney smell. Now, the arrangements of some of the cuisines at the model dwellings at the Exhibition, especially the cuisine of the ouvrièrs de Paris and that of the Mulhouse, are particularly deserving the attention of English visitors for their fireplaces.

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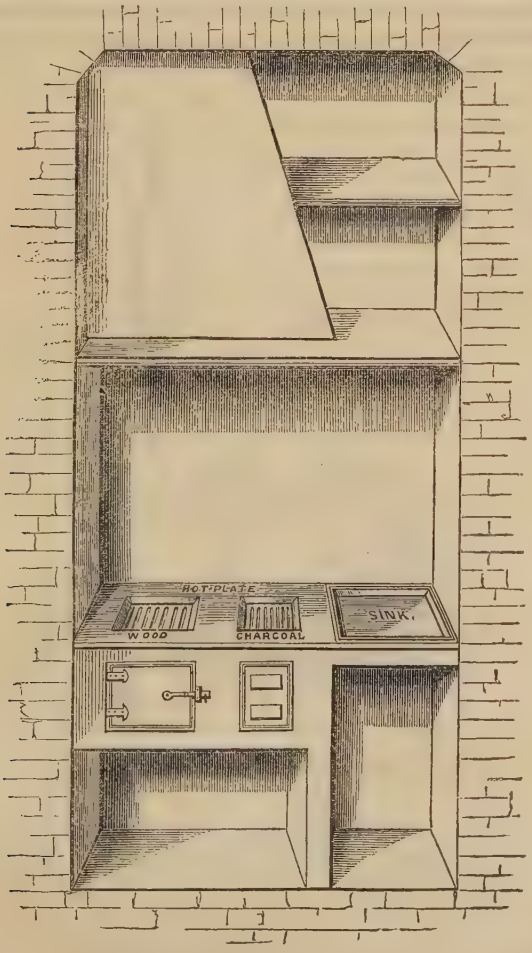
"The smoky house" smell.

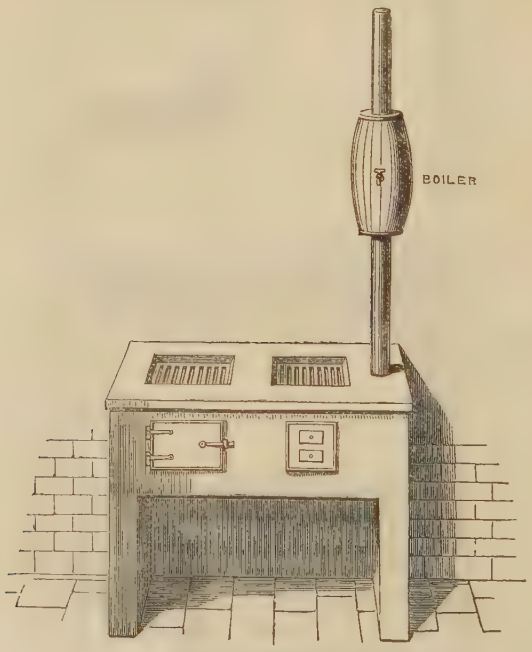



VIEW OF COOKING STOVE, SINK, HOOD, SHELVES, &c. IN KITCHEN.

MR. CHADWICK ON DWELLINGS.

The foregoing is a view of the arrangement without the neat well chosen pots and pans, which are placed on the shelves or suspended on the wall. To the left is a hood for collecting and carrying away the fumes from the cooking apparatus.

The housewife of the Mulhouse cottage claimed for her cuisine the preference on account of the greater room it afforded her for larger operations, including clothes washing, and it was admitted to be an arrangement of merit. The Parisian workman's cuisine had the advantage of a cheap gas apparatus, supplementary, or at times in substitution of the coal-fire. The Mulhouse cuisine had the advantage of one ingenious contrivance for economizing chimney heat, by a copper vessel placed round the stove-pipe and filled with water, which was kept hot by the ascending heat, the sink being kept apart in larger space.




STOVE IN THE KITCHEN. MULHAUSEN COTTAGE.

But the one from Mulhouse is a marked example of economy of the heat ascending the chimney. Surrounding the stove flue is placed a brass vessel, which is filled with water by hand, and is furnished with a tap. It is kept heated for use by the ascending chimney heat. The like economy of chimney heat I found displayed on a large scale

in the Hôpital de la Riboisier, where a worm surrounds the interior of a large chimney, and is filled with water. It was stated they got 60 per cent. of the chimney heat by this contrivance. The water thus heated is led off to water cases to warm other parts of the building.

The town smoke question.

This cottage-heating and cooking question forms a large part of the towns' smoke question. The economies of fuel practised in France, on account of the dearness of fuel, makes the chief difference between the atmosphere of Paris and London. Let any Englishman compare the two, and imagine in how short a time those bright white-fronted houses of Paris would be as soot-begrimed as St. Paul's if they were under a London smoke; yet I have ascertained that by the economy of fuel in large edifices warming is often as cheap in Paris, with coal at more than double the price, as it is in London. The contract price for warming the Madeleine, with 60,000 metres of space, is 14f. per diem. The contract price of keeping up the heat of a hospital to 61 deg. Fahrenheit, night and day, and giving 2,000 cubic feet of air per hour to each bed, at a cost of 1*d.* per diem for the 24 hours in the La Riboisier hospital, and the contractor acknowledged to me that one-half the price was the reward of his service of attention. At this rate of charge for warming and ventilating a block of model dwellings, like the Peabody dwellings, would be, for the 12 hours, about 4½*d.* per room per week.

Economy of warming in Paris.

The waste of fuel and of smoke in the great number of dwellings involves an excess of washing and the wear and tear of linen. English ladies resident in Paris declare how much longer linen is kept clean there than in London—perhaps double the time; and I have estimated that the washing bill of our metropolis is at least 5,000,000*l.* per annum. In appreciation of the importance of the subject the British Commission proposed a committee and a testing house for testing the heating and cooking powers of different forms of grates, kitchen ranges, and boilers, as also the illuminating powers of different gas-burners and modes of lighting, and the testing-house has been brought into operation in the British annexe by Captain Webber, R.E., with the aid of a committee of two military officers for military cooking, and two naval officers for the naval cooking, and two civilians, of whom I have the honour to be one, for the civil service. The researches of the Army Sanitary Commissioners had shown the possibility of large reductions of the consumption of fuel. As exemplifying progress in this respect, I may mention that the coals required for cooking for 1,000 men were more than 22 cwt. a day in the ordinary

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boilers. By an improvement introduced by Captain Grant, R.A., the cooking was reduced to 5½ cwt. or 10½ oz. per man per diem, with a daily allowance of 3 lb. of wood for lighting the fires. But there is now on trial a new cooking range on a new principle, invented by Capt. Warren, R.N., to be seen at the testing-house, which cooks the day's rations for 100 men with only 24 lb. of coal. There is also at the testing-house a locomotive oven, which requires only ¾ lb. of coal to bake better a 4 lb. loaf than is done with 2 lb. of coal by the common baker's oven. The powers of several domestic ranges have been put under trial with advantageous results, as will be seen in Captain Webber's report. But, considering the great importance of the subject, I submit that the trials may be advantageously extended as to kitchen ranges, and also to the warming powers of various forms of chamber fire-grates, with different adaptations, of diameters and lengths of smoke flues, as to which the information varies widely.

The ouvriers of Paris have, however, made one advance of considerable importance in the introduction of gas for intermittent uses. We found the workman in charge cooking his breakfast over a very small and convenient gas-stand attached to the cuisine, which he would probably accomplish for less than a halfpenny's worth of gas, and a saving of half-an-hour of time over lighting and getting up a coal fire, even with an apparatus invented by Captain Donelly, R.E., of a peculiar form of gas burner which lights fires and saves wood.

The extension of the use of gas for domestic purposes would operate proportionately to the reduction of the great smoke nuisance of the towns; and it is to be hoped that the trials commenced at the testing-house of the Exhibition may serve to determine at what point gas becomes more economical than coal.

Test point of the economy of gas for cooking and heating.

The late Mr. Glegg stated that the turning point of economy in the use of gas for heating and cooking purposes was when gas was at about 4*s.* the 1,000 cubic feet. The prime cost of its manufacture on a large scale in London, is stated to be about 1*s.* 9*d.* the 1,000 cubic feet; but it would be of great public advantage to have the point of economy between coal and gas settled by a very special examination and public experiments.

It is one point of sanitary importance with respect to the introduction of gas into dwelling houses that each burner ought to have a distinct channel for the removal of the products of combustion. The facilities of making flues in the concrete constructions will afford means of doing this, and of making each channel an additional means of ventila-

tion. The cowl over the cuisine of both the Mulhouse and the dwellings of the workmen is deserving of attention as a means of keeping the air of the rooms comparatively pure.

In some of the model cottages special attention appears to be paid to the size of the chimneys for the removal of smoke. In the Emperor's new cottages a new principle is adopted. Count Rumford's plan was to narrow the entrance of the flue. In the Emperor's cottages the dimensions of the flues are 10 by 8, and at the exit only four inches, which it is declared works well.

At Dresden, Mr. Semper, the architect, found that circular chimneys of little more than five inches serve well for coal fires for the great majority of buildings for which the large parallelograms are commonly in use. By the better adaptation of size and form, with a better draught of air and better combustion, less coal is consumed as well as less soot deposited. Moreover, by the better draught, much of the heavier and offensive and pernicious gases from the decomposition of coals, more particularly the inferior coals such as are used by the poorer classes, which escape and pervade the living-rooms, when the draught is sluggish or the chimney smokes, is not cleared away. For the larger sized houses flues of $8\frac{1}{2}$ in. are there used; and flues of $11\frac{1}{2}$ in. are found to answer for kitchen ranges and very large establishments. The power of adjusting the size of the chimneys so as to remove the heavier coal gases is one of considerable importance to the cottage dwelling.

A smoke or heat chamber for the tops of houses.

In the Exhibition there is a plan of a M. Leon De Sanges applicable apparently to blocks of labourers' buildings, such as those of Mr. Peabody or of Miss Burdett Coutts, which appears to merit attention. He concentrates all the chimney flues of one house into a smoke chamber at the top; from this chamber there is only one exit. The heat accumulated in the chamber is utilised for heating water for the supply of the lower part of the house. In one I saw it was used for warming a drying closet. At first considerable difficulty was found in the working of the plan until the exit pipe was made of the same sectional area as the collective flues. Mr. de Sanges next found it necessary, for the prevention of down draughts from the chimneys of the fireplaces not in use, to carry a distinct air flue to each fireplace, for its separate supply of outer air. With these amendments, which first checked its application, I was assured, in respect to one house in particular to which the system had been applied, that it worked completely satisfactorily. The advantages claimed for it were:—

1. Ensuring an equal and constant draught of each chimney;

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2. Preventing the disturbing effect of high winds;
3. Suppressing chimney tops;
4. Diminishing the frequency and expense of chimney cleaning;
5. Giving a means, through the smoke chimney, of stopping a particular chimney in the case of fire;
6. Giving heat to a water tank for baths.

M. De Sanges stated that the heat of a smoke chamber in a first-class house was nearly up to the boiling point of water. In large blocks of workmen's, as well as other dwellings, in which there might be several smoke chambers for the collection of the chimney heat, the economy of a perfected plan may be expected to be considerable. But the most important purpose, as it appeared to me, to which it would be applicable would be in supplying a means of ventilation. According to the report of General Morin, the best motive power for the removal of vitiated air, easily, regularly, and economically, is by means of a hot-water tank surrounding the iron cylinders forming the ends of vitiated air flues, and keeping up a current by the expansion of the air by the surrounding heat. I witnessed myself the proof of the great regularity of its action in the Hospital La Riboisier. It appears to me that the same principle is applicable on a smaller scale to private dwellings, and that a hot-water tank for the purpose might be circled or kept heated by the hot air of the smoke chamber, so as to carry on the ventilation of sleeping rooms through the night, which will not be accomplished by the important ventilating chimney which I shall subsequently describe. This may be the more necessary where the chimney draught from each room is diminished by a separate supply of air to the fireplace.

One architectural advantage of the plan in towns would be getting rid of ugly chimney stacks, and substituting a construction which, without much extra expense, would be susceptible of art ornamentation.

The next page contains one of M. De Sanges' plans, exemplifying his arrangement.

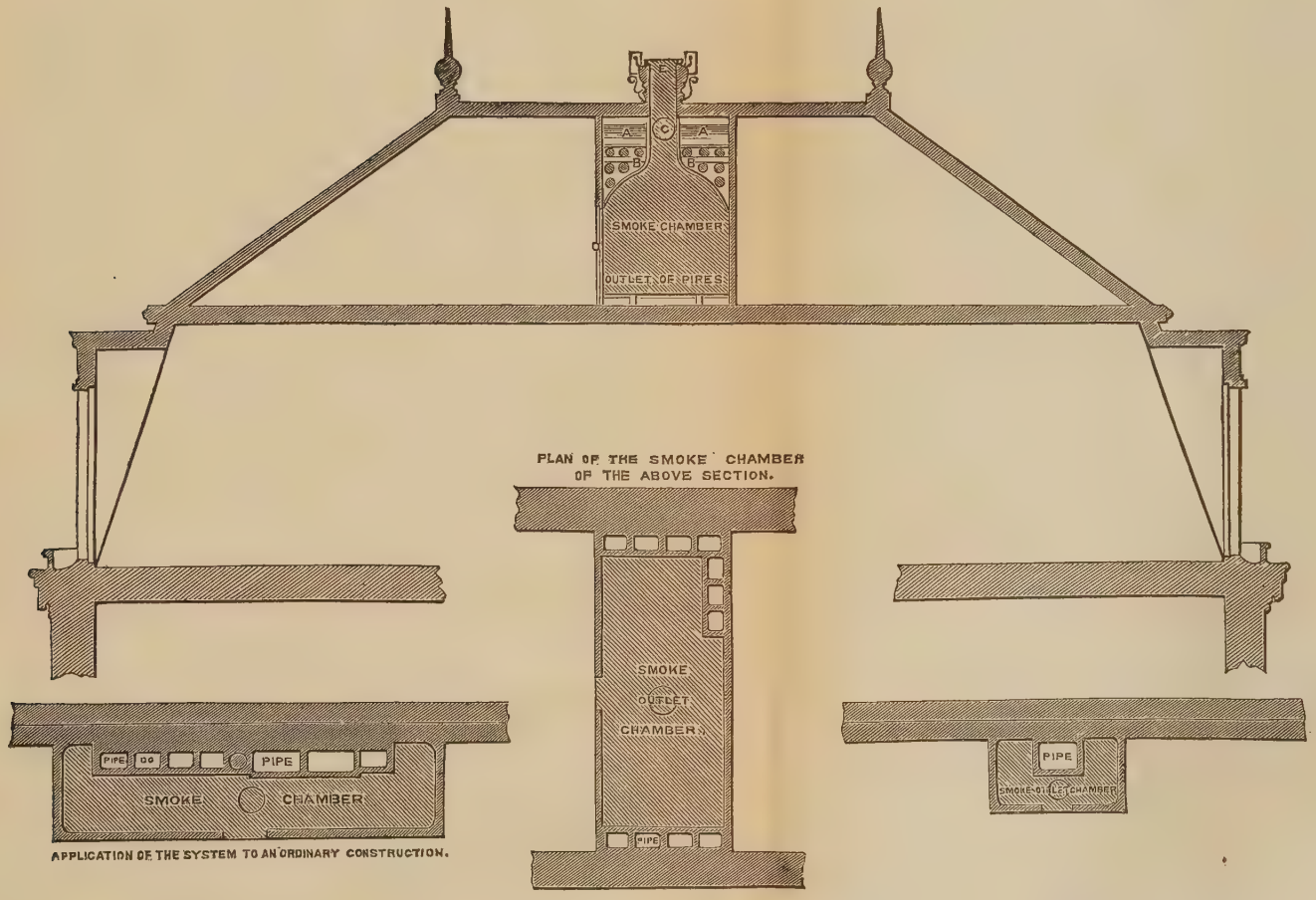
The architect declares that the expense of this chamber is not greater than that of the unsightly stacks of chimney pots which it abolishes.

In the exhibition there is one plan, by Mr. Muller, by which, it is stated, he has overcome difficulties in concentrating the chimney flues at successive stages into one main front flue, so as to avoid the occupation of space in carrying up each flue separately to the top of the building. The same architect has also a most compact laundry, deserving of attention from its arrangement and for the compactness of all the apparatus, as applicable to common washing houses.

VARIOUS EXAMPLES OF THE APPLICATION OF THE SYSTEM OF M. LEON DE SANGES, ARCHITECT.

Scale, $0^{m} \cdot 0105 = 1$ metre.

SECTION OF A ROOF WITH SMOKE-CHAMBER ABOVE FALSE FLOOR.




APPLICATION OF THE SYSTEM TO AN ORDINARY CONSTRUCTION.

APPLICATION OF THE SYSTEM TO A CHIMNEY WITH THE ADVANTAGE OF DRAUGHT, SWEEPING, AND SUPPRESSION OF THE PASSAGE OF WORKMEN TO THE ROOF.

A. Warm water. B. Spiral hot-air tube. C. Ventilator. D. Door. E. Smoke outlet.

He has one principle of great importance—of saving friction of linen in washing, by pumping the soapsuds from the bottom of the vessel in which the clothes are washed, and passing it through the linen without rubbing. I had the testimony of the lady of a private establishment where the principle was applied, that the saving of clothes by it was very great—a saving of importance, when it is considered that clothes are far more worn by the washing in the common methods than by their wear.

The living-room of the Mulhouse dwelling is warmed by a tall cylindrical iron stove, the flue of which is so adjusted as to create a ventilating current of heated air from that to the upper rooms. In respect to warming by the common close stove by large iron surfaces, there is a sanitary objection which does not attach to warming by earthenware surfaces. The iron surface, as it is commonly expressed, "burns the air," and creates disagreeable conditions which are appreciated by the lungs and the nose, but which chemists have not yet analysed. There are in the exhibition various forms of earthenware-covered stoves, and some open fireplaces adapted for labouring as well as other dwellings. Some of the forms will be seen in the Austrian department, as also in those of Sweden and Norway, as well as some in class 24, to which I have already adverted, in the Prussian department, though those are stoves of a higher class. Americans, accustomed at home to warming in winter by iron heated surfaces, declare how much more agreeable, how superior, the air is in Sweden and Norway in the rooms warmed through earthware surfaces. On the other hand, I have heard Swiss who are accustomed to house warming from pottery stoves declare that they find, when they go into some parts of Germany, the house warming by the iron close stoves extremely disagreeable and often unbearable. The effect on health is very important, and an Austrian or Swedish earthenware stove of the economical types in the Exhibition might well be substituted for the iron one used in the Mulhouse dwelling.

The iron surfaces of the French economical kitchen ranges, and of some of our own, is an objection to their use, especially by ladies, that would be removed by covering them with a tile surface, which need not be of an expensive quality, and would, from its non-conducting power, be at the same time economical of heat. There is in the test-house one example of an English warming stove so covered, though with tiles of an ornamental and expensive description, which would not be necessary for cottage use. Chemists have hitherto failed to account for this effect of warming by heated iron surfaces, but General Morin assures me he has

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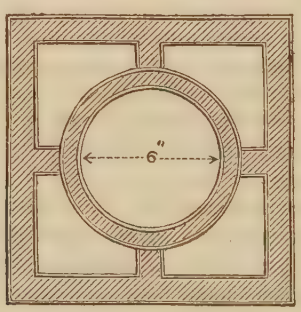
detected the cause, and an explanation of it from him may be shortly expected.

## THE COTTAGE VENTILATION QUESTION.

The nose test of sanitary conditions.

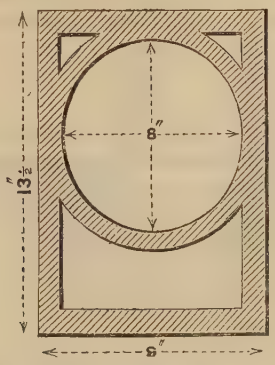
All the French model dwellings, except those of the co-operatives of Paris, follow the English model cottages in providing openings for ventilation, but do not advance upon them. In my view, most of the means used are entirely insufficient. I proposed to the international jury that they should apply what I call the "nose test," which is far better than any at present known chemical tests, to the various methods of ventilation of dwellings, and that they should do it in this way—by going in early morning, before the inmates had risen, and, permission being obtained, put their noses into the sleeping room. But I failed in persuading them to adopt my proposal. Physicians who are called upon to visit the sick at all hours have painful experience of the foul state of the atmosphere in which the poor commonly have but imperfectly refreshing sleep.

In suggesting some plans of cottage constructions of hollow brick, I proposed a tubular chimney made by a tile machine, on this section, which was given in the plan of a cottage submitted to His Royal Highness the Prince Consort.




It appeared to me that the angles of the smoke flue might be utilised as air flues, which might be used for the removal of vitiated air by the action of the heat of the smoke flue, for ventilation. The action of the smoke flue will be the more regular, from the interior being confined to its proper service, and from its having the least admixture of cold air. The same principle was subsequently adopted for earthenware tile chimneys by Messrs. Doulton, of Lambeth, but with a variation in construction displayed in the following section; and it is reported that it acts satisfactorily. It has

been proposed to use the external action of the chimney heat, in various modes, for the removal of vitiated air, but we have now introduced a most important, tried, and proved method of utilising the chimney heat for the introduction of fresh air and for warming houses.




A new ventilating chimney.

Amongst the fire-grates exhibited in the testing house was one invented by Captain Douglas Galton, R.E., C.B., who has connected with it a principle of warming and ventilation, which, as developed by some trial works and experiments appears to me to be one of the most important sanitary inventions of our time.

In plans for warming and ventilating soldiers' barracks, Captain Galton struck out the principle of adapting the chimney heat of the smoke flue for bringing in a supply of fresh warmed air, by carrying, parallel to the smoke flue, a fresh air flue, which leads the fresh outer close to the smoke flue, the heat of which expands the fresh air, and causes it to rise in current, which is discharged near the ceiling of the room, across which it spreads. It then descends and mixes with the colder and heavier air beneath, and it is carried with the current into the open fire-place and is thence discharged as vitiated air through the smoke flue. The smoke flue surrounded by a fresh air flue constitutes a pump,—pumping into the room warmed fresh air, in quantities proportioned to the warming power of the smoke flue, and the adjusted size and length of the fresh air flue.

Captain Galton's first experiments were with a fresh air flue carried parallel to the smoke flue and warmed by it. I had met with an example, in principle very near this, and had given a plan of it in my report of 1842, yet I confess I overlooked it. General Morin saw and appreciated the importance of the principle, and made a number of careful

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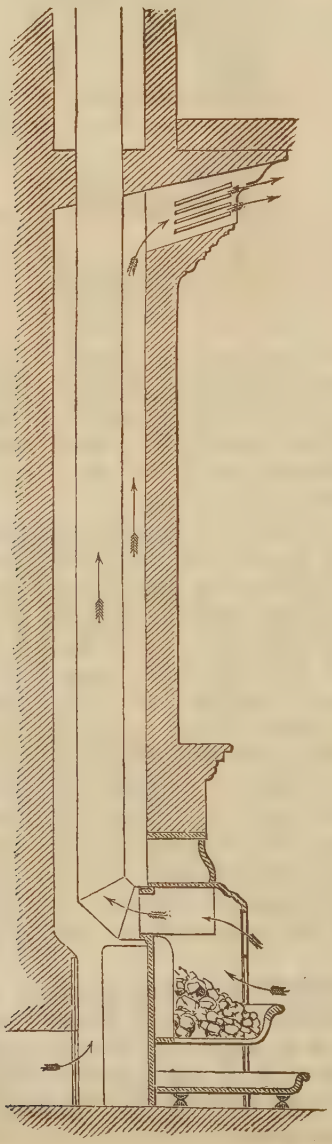
experiments with it, with the fresh air flue surrounding the smoke flue, and has obtained important results with it. The principle of the invention is displayed in the following section.

CHIMNEY VENTILATOR.

Fig. 1.



The following are the elevations and plan of Captain Galton's grates, attached to the flue. But the General states to me that the greater number of cast-iron fire-places, on existing systems intended for coal and coke, can be easily and economically fitted with the arrangements described, though Captain Galton's fire-place has the advantage of throwing into a room more of radiant heat with a given quantity of coal.

Fig. 2.

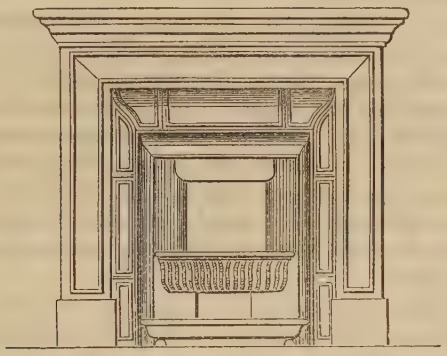
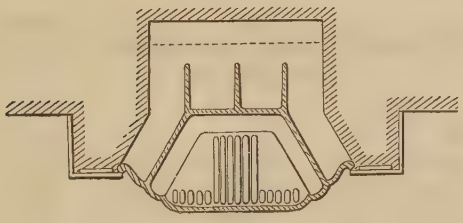


Fig. 3.



The General has determined that the air of the room will by this fresh air pump properly adjusted change the air of the room at least three times an hour, and in respect to the warming, whilst under the common arrangements only one-eighth of the chimney heat was gained, by warming the fresh air with the ventilating chimney at least one-third of the heat is gained. Another effect produced by the invention is the maintenance of an equable temperature in all parts of a room, and the prevention of draughts. The soldiers in the barrack rooms where the principle has been supplied, state that they are now better warmed, and that they are not now roasted in front whilst they are frozen behind, as they were with the old grates. It prevents smoky chimneys by the ample supply of fresh air created

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in the room, and by the draught created in the neck of the chimney, especially those of the peculiar form of grate invented by Captain Galton.

Dr. Parkes, of Netley Hospital, the author of the Manual on Hygiène has caused experiments to be made which show that at the rate at which the air passes through the fresh air flue, and the short time of its contact with the heated surface of the smoke flue, it is carried into the room without being "burned" or "dried," or its hygrometic condition being materially altered.

The invention supplies are important desideratum for the ventilation of dwellings in flats, such as most of those occupied by the wage classes in our crowded towns. The rooms on these flats are usually ventilated from the common staircases, which I will call an aerial common sewer, carrying with it vitiated air from the lower floor, and from the rooms of each stage opening into it. Now by the invention* each room would derive its supply of fresh warmed air, and its ventilation from without and independently of every other part of the premises.

General Morin has been so good as to give me the following table of the results of his experiments as to the sizes of smoke and air flues adapted to different sized rooms.

| Cubic contents of room to be heated. | Probable dimensions of room. | Volume of air impelled and admitted per hour. | Section of smoke pipe. | Area of passage of chimney top. | Total section of passage for admitting fresh air. |
|---|---|---|---|---|---|
| cubic ft. | feet and inches. | cubic ft. | sq. in. | sq. in. | sq. in. |
| 3,600 | 20 × 15 × 12 | 17,658 | 77·5 | 38·7 | 217·0 |
| 4,320 | 24 × 15 × 12 | 21,189 | 93·0 | 46·5 | 260·4 |
| 5,376 | 28 × 16 × 12 | 26,487 | 116·2 | 58·9 | 325·5 |
| 6,480 | 30 × 18 × 12 | 31,784 | 139·5 | 69·7 | 390·6 |
| 7,840 | 32 × 17 6 × 14 | 38,847 | 170·5 | 85·2 | 477·4 |
| 9,180 | 36 × 17 × 15 | 45,910 | 201·5 | 100·7 | 564·2 |
| 10,560 | 33 × 20 × 16 | 52,974 | 232·5 | 116·2 | 651·0 |

It is to be hoped that the important principle will soon be seen in extensive and varied application, which may be facilitated by a work which General Morin has in preparation, containing the results of all his important experiments on warming and ventilation.

I did not find in the foreign part of the Exhibition any instance of the application of the syphon principle in ventilation. At the head of the staircase of the dwellings of the

* It is to be observed that neither Captain Galton's grate nor the chimney are patented.

ouvriers of Paris such an apparatus as that of Muir's ventilators may be commended, especially in the larger blocks of dwellings, to remove the vitiated air accumulated as in inverted receivers in the upper apartments. In the tall houses let off in flats in Edinburgh and in other towns, it was common that attacks of cholera were chiefly on the occupiers of the basement floors, and on those in the attics, leaving the dwellers in the intermediate tenements untouched—that is to say, the attacks were chiefly in the ratio of the vitiation of the air. As marking the backward state of sanitary science in house construction, it is to be observed that in a large proportion of instances in the new and largest first-class houses in Paris the servants' sleeping-rooms are mere unventilated cells, called "coffins," in which the inmates are crowded together in a manner equally destructive to health and to morality.

The power of warming hollow walls, on the principle taken up by the architect of the Co-operative Society, and also the power of warming hollow floors, are means of promise to induce people to keep open the doors and windows of their living-rooms for the most free aeration in summer time, when fires are not used. The experiments and observations of General Morin, to be found in the transactions of the *Conservatoire des Arts et Métiers*, but which he promises to publish separately, appear to me to make important advances to definite principles of ventilation in their application to large public edifices, that are as applicable if not to detached cottages and urban block buildings, occupied by the wage classes, when due attention is paid to them, as they are proved to be to our prisons. It is an advance that some of these block buildings are now let sometimes with water and gas laid on, as part of the rent; but a further advance may be made in such block buildings in letting rooms warmed and ventilated, and in the heats of summer cooled as well as ventilated, from pure air sources, night as well as day, with hot water laid on, and that, too, with an economy of the existing charges. Seeing indeed what has been done by sanitary engineering for the best hospitals and the best prisons, it is surprising that no application has yet been made of the ascertained principles to new and grand hotels, and even to the cabins of large ships. The leading principles of ventilation which it appears to me General Morin has determined, are—1st, the superiority of the principle of ventilation by suction, by the method of the hot-water tank acting in the vitiated air flues, over the existing method of ventilation, by driving fresh air into rooms by steam power. 2nd, the principle that the vitiated air should be taken out as

Settled principles of ventilation.

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closely as possible from the sources of vitiation; in hospitals near each bed. 3rd, that for the avoidance of the inconvenience of draughts, that fresh air should be brought in from a distance, to the place of supply. These principles may now be applied to the removal of air in exactly fixed quantities and temperatures; and 4thly, that the heat in entrance halls, passages, &c., should be kept up to the same heat as the inner chambers. But in the practical adaptations of clearly ascertained principles there is a great deal to be studied, and there are trial works to be made, to overcome the difficulties which yet beset the important subject. Meanwhile, attention should be given to the prevention of overcrowding, or to the massing of the people too closely together, of the effect of which we have had samples in prisons and other public institutions. Thus in the Dartmoor prison for military prisoners, which is situate in one of the healthiest sites in England, on granite at a great height. When it was greatly overcrowded the inmates were horribly ravaged by typhus;—when the numbers were reduced to a certain extent, typhus disappeared, but phthisis remained;—when the numbers were still further reduced phthisis too almost entirely disappeared, and there prevailed a state of health befitting the site;—the case exemplifying a principle in my observation, that different doses of aerial impurity have different classes of diseases attendant upon them. Dr. H. Hunt, who is a good observer, seeing the sequence at the Dartmoor prison, has prescribed to patients with incipient phthisis to take residence there; to have no second person in the living room, and always as much as possible to keep the doors and windows open; and this treatment has been eminently successful. Good ventilation might have mitigated the overcrowding, and produced the beneficial effect of the last stage in the second stage. Missionaries (in the South Sea Islands) in ignorance of sanitary laws, have induced their flocks, who had been accustomed to sleep in huts with the tops open to the air, to betake themselves to live in closed houses like Christians, and have certainly brought upon them European diseases, which they never had before. Natives who were ill returned to their open huts and got rid of the new disease.

Natural ventilation, results of.

### The Cottage Water Supply Question.

Defects of water supply in common dwellings.

All the foreign model dwellings are intended to be supplied with water by hand, brought from wells or from public fountains; none are presumed to have pipe water supply.

It appears to be matter of surprise that in Paris, with unity of administration, and with such undoubtedly able

administrators, the interests of water-carriers should be allowed to prevail, and an improved and superior pipe water-supply should not have been obtained.

In some of the model dwellings, those of Mdme. Jouffray Reynault, I found that the inmates paid a sous a day, or 3½*d.* per week, for what we should consider a scanty supply brought to them by water-carriers. Where a city is supplied with a constant supply of more than 20 gallons per head, or a supply practically unlimited, and which is carried up to the highest tenements as a public service, it ought to be at a penny a week or at a rate which makes it dear to the poorest person to go from the top of the house to a yard to fetch it, although it may be had thence for nothing. In such cases as those of the isolated blocks or cottages, such as in the instances of the Emperor's new cottages or dwellings, the Mulhouse dwellings, or in cases where pipe-water or well-water supplies are bad, it is a mistake not to make provision for the reception, in underground tanks, of the rain-water from the roofs, as that water, when properly preserved, is of great value for washing, for cooking, and for making tea, for which last purpose it serves to procure about one-third more and better extract than common hard or mineral waters. Soft drinking water adds to the solubility of all food, and as an aid to digestion, was prescribed successfully by the late Dr. Prout, to dyspeptic people; and where natural soft water was not to be had he prescribed distilled water, though it is very flat from being decerated. I have known dyspeptic people to get well simply by a change from a hard to a good soft water.* When rain water is caught in the common method it is, however, kept stagnant, in open butts or receptacles, often near cesspools, or near the dung-heaps of outhouses, the foul air from which it rapidly absorbs, toge-

Cottage economy artificial water supplies.

Advantages of soft water supplies.

* What Miss Nightingale says of water for the service of the sick in hospitals is applicable to a great extent for the use of those who are not sick. "The water must be soft; people think very little of this. They think "mainly of hard water as chapping the hands, not as being a promoter of "drunkenness, uncleanliness, and indigestion. It is very little observed that "water dressings, every day more used by surgeons, have absolutely the op-"posite effect, viz., poisoning the sore, when made with very hard water, to "what they have, viz., cleansing and healing the sore, when the water is soft. "When water is hard, it is worth while to have distilled water for every "water dressing. For all washing of the sick it is worth while to collect rain "water or condense steam from a boiler, or to boil water, which will often "remove from one-half to three-fourths of the hardness. Soap and hard "water actually dirty your patient's skin. The oil in the soap, the exudations "from the skin, and the lime in the water unite to form a kind of varnish "upon the skin, which comes off in the above-mentioned black flakes when "rubbed."

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ther with floating spores, of vegetation and animalcules, and it becomes often more unwholesome than hard or mineral water similarly exposed. Pure soft water is, I believe, of so much value, that in the chalk districts or in other districts where it is not to be got, it is worth while to prepare roofs expressly to catch it, and underground tanks to preserve it pure. In Britain it is estimated that the average quantity of rain water which falls on a square yard of surface in a year is 126 gallons. Three yards would give rather more than a gallon a day; or a surface of 100 yards would give 12,600 gallons, or 34 gallons per diem, or about 6½ gallons per head to an average family of five. If this were insufficient for the purpose of the household, it would be worth while reserving it for drinking and for washing the person, and the more special uses. The collection of the rain water is one important use of a flat roof, properly prepared by an inpermeable surface of hard tile or other material to which access may be had for cleansing it from soot or bird's dung before any coming rainfall, of which the first should be allowed to run to waste. A deep underground covered tank,—for which concrete faced with impermeable earthenware tiles, are the best materials—should be prepared to receive it, and keep it cool, and out of the way of any floating cause of impurity. The best trainers of racing horses in England are very careful to do all this for their horses, and even to have water carried with them for the use of the horses at races. I was glad to hear the intelligent foreman engaged in the construction of the Emperor's model cottages, near Vincennes, point out the absence of any proper provision for collecting and storing rain-water, as a serious defect in them. He had constructed receptacles for the purpose in various parts of France, and he bore testimony to the high order of their utility to the poor. In densely populated districts such provisions are scarcely practicable, and under good public administration, collective arrangements may be made with greater efficiency as well as vastly greater economy. The estimate of one engineer, Mr. Bateman, for bringing an ample supply of soft water from the Welsh mountains, beyond the Severn, to the Metropolis, is a charge of about 6*s.* per head per annum of the population, including even compensations for existing works. Our estimate at the Board of Health was much less than that even for bringing fresh water from Wales. But we found that upwards of forty-six millions of gallons of soft perennial spring water of a superior quality, pure, free from the taint of peat, and well aerated, or double the then actual consumption of the metropolis, might be had, by proper

Quantity of rain water available for house supplies.

Cost of soft water supplies from long distances.

administrative consolidations, within the existing charges. Yet, as a matter of sanitary economy, a charge of $1\frac{1}{2}d.$ per week per head of the population, for an ample supply of pure soft water, would be a great saving. Nevertheless, it is to be borne in mind, that the best water may be made bad by the method of distribution. If water, instead of being delivered by constant supply from the steam pump direct into every room, cool, fresh, and well aerated, be detained, as is the practice of some engineers, and spread out into large open reservoirs, where it is deaerated, and vegetation is rapidly engendered, attended by animalcules, and impurities contracted which no after filtration effectually removes; or if it be delivered direct only intermittently, so as to be stored only in open butts, to be kept in them, near cesspools or in cesspool-tainted atmospheres; or even it if be delivered direct, by stand pipes in the courts and alleys, occupied by the wage classes, and has but to be carried up to their close, crowded, cesspool-tainted warm rooms, and kept standing there in pails and mugs, it is rapidly decerated and absorbs the foul air of the place, becomes flat, often tepid, and positively nauseous;—water delivered under such conditions, it fails to stay the appetency for strong drinks, and fails of sanitary results, as proved where new and improved supplies of soft water have been obtained, and where it has failed to arrest increasing death rates, as in the large and flagrant results of Glasgow, Liverpool, and Manchester, where from neglect or incompetency to attend to the sanitary conditions influencing the dwellings of the wage classes there is with the greatest local prosperity, and the highest amount of wages, the heaviest mortality.

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Deterioration of good water by bad modes of delivery.

It is an important principle, which should be acted upon, that ample supplies of water, conveniently placed at hand, must precede the formation of habits of personal cleanliness, by regular head-to-foot ablutions. By such ablutions the people are armed, as it were, against epidemics and passing causes of disease. Moreover, their food goes farther. Four members of a family that are regularly washed will be kept in as good a condition on the same amount of food as five that are unwashed. Even pigs that are regularly washed and kept with clean skins put on one-fourth more flesh with the same quantity and sort of food that is eaten by pigs that are unwashed. In well-managed prisons, where the cells are well supplied with water, where the prisoners are made to have head-to-foot ablutions, where there is good ventilation kept up, and where wall smells are prevented, and drain smells excluded;—although there is a watercloset in each cell —in these dwellings, although the diet is much lower (ex-

Economy of head to foot daily ablutions.

Mr. Chadwick on Dwellings.

cept that there is good milk as part of the vegetable dietary), epidemic attacks, and almost all spontaneous acute disease is abolished;—typhus, or the gaol fever, is now unknown there; and there is less than one-third of the sickness and death-rates prevalent amongst the general outside populations.

One obstacle to the extension of the minor distribution of water into houses and rooms, so important for cleanliness and health in cottages, is that it is often, in the present condition of the common apparatus, an extension of waste.

Wasteful modes of delivering water.

In the metropolis and many cities and towns, fully three-fifths of the water is pumped in waste, partly from the defects of intermittent supplies and neglected ball-cocks and overflows of cisterns in the house, and numerous pipes letting the water run away, in the notion of clearing bad drains and bad sewers of deposit. As a check to this waste lower rates should be charged on houses proved, on inspection, to have self-closing taps or meters or other waste preventers. Another obstacle to the improved internal distribution of cottage supplies is the practical difficulty of carrying water-pipes inside the thin walls, or of attaching them to the soft lath and plaster walls, or to the soft surface of walls such as those of the model dwellings in the Exhibition.

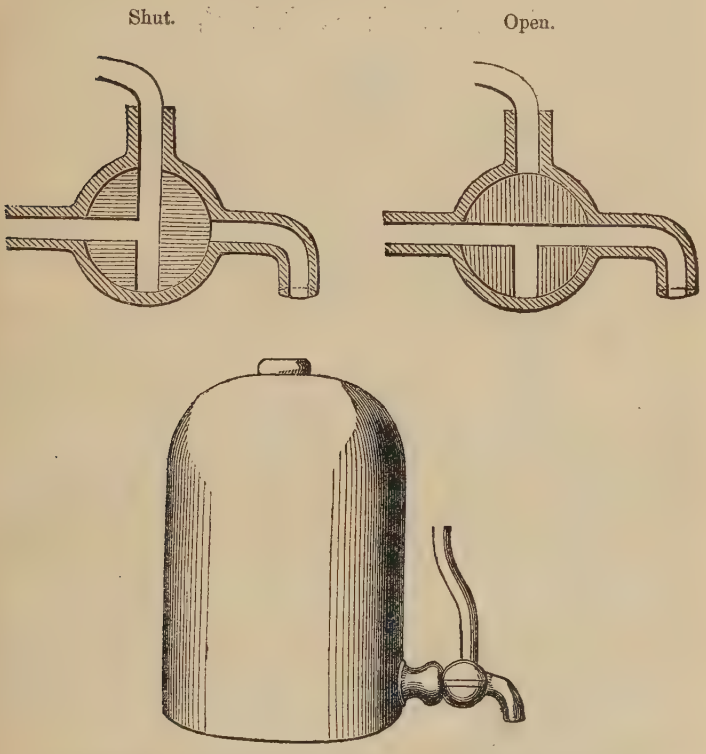
I did not see in the Exhibition any examples of a very important invention presented to us 15 years ago, at the General Board of Health, by Mr. Philip Holland (one of our then inspectors, now inspector of the health department of the Home Office), by which these obstacles were provided

Economical mode of distributing water in dwelling rooms.

against. He used very small pipes of glass or of gutta-percha, of a size, or with a very small bore, not larger than that of a tobacco pipe. Small lead piping, tinned or protected inside, as has been done by an enamel, against the action of the water, would also serve. The small-bore water-pipe enters a vessel of earthenware, or of the cheapest glass, which is closed at top, and it enters by a three-way tap. The water passes through the pipe very slowly, a mere ooze, compressing the air until its tension equals the pressure of the water when no more enters. With the pressure of about 100 ft. the air is compressed to one-fourth its usual bulk, a gallon bottle contains three quarts of water and one of air, the pressure of which forces out the water, when the tap is turned, as fast as it would do if the supply-pipe were of the size of the tap, getting gradually slower as the closed bottle is emptied, and then ceasing altogether, as the three-way tap prevents the water flowing in and out of the vessel at the same time. For a wash-stand a gallon

vessel will suffice, even for a complete personal ablution (with a sponge or a wet towel). For a scullery or cuisine, such as those in the model dwellings, one of three or four gallons is enough. The following are sections of the three-way tap, open and closed, together with a view of the vessel.

A THREE-WAY TAP.




VESSEL FOR CONTAINING WATER AND COMPRESSED AIR.

The vessels are refilled, and are intended to be refilled, only very slowly, after each charge is drawn, as the slowness prevents waste. The consumer must wait until the fresh supply is obtained. In the case of breakage apartments are not flooded, as in the event of the breakage of a pipe of the common bore; and vast aggregate wastes are thus preventible The small piping may be carried along the cornice of rooms, where it is little more seen than bell wires. Where exposed to frost it may be inclosed in a pipe made of bitumen and paper, which is a good non-conductor.

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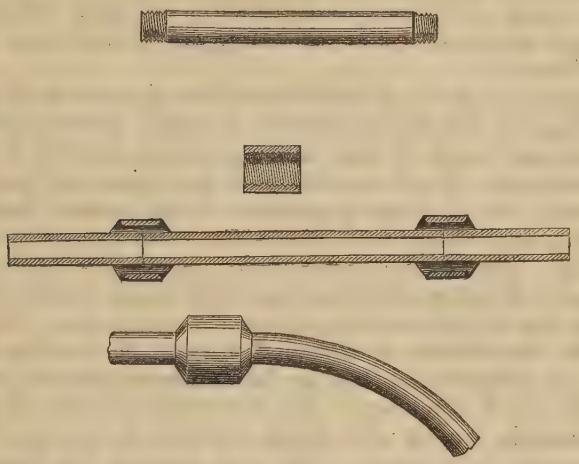
By the saving from the substitution of the very small pipes for the large pipes now commonly used, this simple apparatus is much less costly than common cisterns. The cost of supplying every room of a dwelling with water need not be greater than that of supplying one cistern only. The saving of the trouble of fetching and carrying up water into rooms on this system of constant supply is considerable, besides the advantage of avoiding the risk of receiving the impurities to which all water kept stagnant in open cisterns—commonly placed so as to absorb the deleterious gases of cesspools or refuse heaps of close habitations—is exposed, for on this system the water is never exposed to such foul air. By the evaporation of a wet cloth thrown over the vessel in hot weather, the water may be kept cool and well aerated for drinking—a great advantage for health and temperance. In special cases, for sick rooms, receptacles may be provided to be easily charged with carbonic acid or oxygenated gas, which would be absorbed under constant pressure.

This distributory apparatus is peculiarly eligible in cases where there is in the neighbourhood of any *cité ouvrière*, village, or town, a peculiarly good spring or supply of water well fitted for drinking or for culinary purposes, leaving any other less pure supply that serves for other ordinary purposes to be distributed in the ordinary way. On this system of supply, the mains may, with pressure, be relatively as small as the minor or capillary distribution pipes. Whilst there is proper grief and severe denunciations of the waste of means by the wage classes in the cabaret or the beershop, it is overlooked that at present, in most towns, their common alternative is of water usually discoloured and repulsive to look at, flat or nauseous to the taste, and utterly unfitted for drinking. The first step in improvement is to secure by administrative means such water for *their* tables as would be admissible in water bottles for *ours*.

Distribution with earthenware piping.

Some waters act upon metal pipes more powerfully than others, and on lead pipes very injuriously. Vitruvius states that the Romans distributed water in earthenware pipes at 100 ft. of pressure. Some years ago I got some trial works made of the strength of stoneware pipes, subjected to a second mechanical pressure, when it was found that they bore pressure equal to a head of more than 1,200 ft. of water. Our engineers who tried them failed, however, in several instances; but in the French annexe of Class 65 there are to be seen specimens of red earthenware glazed pipes for the distribution of water, with testimony of success in a number of towns, under various high pressures. The failures of the trial works in England appear to have been with the common

spiggot-and-faucit joints. The success under the practice of Messrs. Constant Zeller appears to have been with joints, wide and strong rings of Portland cement covered by rings of earthenware, thus :— MR. CHADWICK ON DWELLINGS.



The objection to the use of earthenware for water distribution on a large scale, and for the interior of houses, that it won't stand it, is that it does stand it. Mulhouse and a number of other cities in the north of France, several in Switzerland and Germany are supplied with water in earthenware pipes laid down by Messrs. Constant Zeller. The greatest pressure at which they have been called upon to lay down earthenware pipes is 60 metres. But it did not strike me, that their red earthenware glazed pipes though obviously well made, were so strong, as we had some vitreous stoneware pipes made in England, some of which stood a pressure of as much as 500lbs. the square inch, or upwards of 1,000 feet of altitude. At some of the points of the most severe pressure it appears that the Messrs. Zeller put in short lengths of lead pipe to withstand the hydraulic shock, which is otherwise duly provided for by water cushions. The highest pressure they have got particular earthenware pipes to stand appears to be 34 atmospheres.* Here, however, is an established and proved practice of laying down earthenware pipes, and their working at upwards of 120 feet of pressure, at more than a hundred places, towns and villages in France. The advantages of the earthenware pipes over the metal are, greater

Advantages of earthenware pipe distribution.

* Vide tabular results, p. 190, Appendix to Minutes of Information of the General Board of Health, on the removal of soil matter and the sewerage, and cleansing of the sites of towns, p. 152.

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purity, indefinite durability, and it is alleged that they are less subject to derangement, more easily repaired, and less expensive to keep up, and are laid down at half the first cost of metal pipes. One result of this is, that by means of these pipes a pipe-water distribution has been effected in villages where the price of iron pipes would have been prohibitory.

There were in the Exhibition various pipes made of paper and bitumen for the distribution of water, whether tried or not for any length of time under constant pressure I could not ascertain. But I am informed that pipes of beton or concrete, with a large proportion of very strong Portland cement, have been used under moderate pressures, with success. The late Count Gasparin, the most scientific agriculturist of Europe, informed me that, being unable to get either iron or earthenware pipes at his estate near Avignon for the distribution of liquefied manure, his brother made pipes of concrete or beton, by the following method, which may be worth knowing :—He distended a flexible hose of the suitable length with water, and laid it on a level bed of concrete in a trench. He then covered the distended pipe with concrete, and when it was set let out the water from the pipe, which had been so covered as to protect it from the adhesion of the concrete, pulled it out, and proceeded to refil it with water, and to form another length of beton piping in the same way. With these pipes the Count made fountains for his gardens.

Concrete pipes, mode of making.

## The Cottage or Dwelling-House Drainage and Cleansing Question.

The house cesspool question.

The sanitary principle of constructive arrangement to be striven for is that all animal and vegetable refuse matter shall be constantly removed from within, or from about, or from beneath or near habitations, from beneath the sites of houses, of streets, or of towns, before it enters into advanced, which are the noxious, stages of decomposition. For this purpose there is no method so cheap or so efficient as by the reception and immediate removal of excreta in suspension in water. There is no mode of arresting decomposition and saving and applying it to manure so efficiently and cheaply as in water. All the French model dwellings now adopt the English water-closet as the means of effecting this object, though I did not consider they were quite so good as those in the model dwellings of the Prince Consort. The cost of maintaining such an arrangement within a house in good working order ought not to exceed one penny per week. Experience in England has shown that the syphon closet is

Economy of a proper water-closet.

the best under all ordinary conditions, when a proper supply and scour of water and trap is applied to it. The closets on the principle of the flap-trap are all objectionable, as being more expensive, and as usually keeping an accumulation of soil underneath or about them, though out of sight. Little attention appeared to be paid to the economy of water for the service, which varied from half a gallon to two gallons or more. A proper and complete apparatus of the syphon type should be connected with a self-cleansing house drain (properly trapped to prevent the regurgitation of any products of decomposition arising from accident), and the interior house drain must be connected with the self-cleansing sewer, both of which may now best be made of a proper and smoother concrete, free from the interruptions of joints, has now been done in some instances in Paris with the Beton Coignet, and I am informed it has also been done successfully with one form of concrete at Zurich and at other places on the Continent. The advantages of a skilful application of these new modes of construction to house as well as to town drainage will be considerable in economy, as well as in efficiency, in getting better adaptations of lines and gradations than are given by the common manufacture of tubular drain pipes, which were the first gain upon the rude rough brick or rough stone house drains.

Concrete house drains and sewers.

The extended use of the water-closet is, however, opposed on the ground of the waste of manure. But manure is best preserved by its immediate reception in cold water, which arrests decomposition, which is detected by the nose in the escape of noxious emanations, and prevents waste; and in the liquefied form the manure ought to be removed and deposited, within the day of its production, on fallow land, and deposited there not in mechanical suspension, but in chemical combination.

Economy of manure by reception in water.

The first stink of fœcal matter is to be taken as a warning for removal, or worse will follow the products of decomposition which are of a different nature. It is a result of considerable observation that, in ordinary weather in England, the incipient decomposition of sewage begins about the end of the first day, and advances until there is very full decomposition, usually about the fourth day. But it ought and may, by proper arrangements, be all put, within the first day, in chemical combination with the soil, in which condition it is the most securely preserved for production.

Some plans are presented for using prepared earth in prepared closets for the reception of the manure. But even if on these plans the earth were manipulated with the care they require, which with cottagers they rarely are, and if

The earth closet pan.

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they were effectual, they are objectionable on the score of expense, in the labour of preparing the earth, in bringing it to the house, and in the removal of the increased bulk, for a closet, if used by six persons, it is stated will require about 2 cwt. of earth per week to be prepared and applied, or more than $2\frac{1}{2}$ tons per annum, or for a population of 10,000 persons about 13 tons a day. The expense as set down for the lowest class house is greater than that of putting down a soil pan, whilst the annual working expenses appear to be double for the removal of urine and fæces alone, but the mistake is made of regarding such matter as constituting the only sewerage, whereas they form only an inconsiderable proportion of the sewerage proper, in some cases less than a two hundredth part of what is comprised in it, the foul and the waste water, kitchen slops, soap suds, &c., for the removal of which house drains and sewers must be provided. On examples of the use of the dry conservancy system in public institutions, as in some of the prisons in India, where labour is under control and employment wanted, and where the places are near from which earth is to be taken and whence it is to be returned after saturation, it is proposed to apply the system to large towns, where labour must be paid for, and where the places where earth is to be got and returned is distant. In an able report Captain Tulloch, of the Royal Engineers, has demonstrated that a system of "dry" conservancy worked out for Madras would be six times more expensive than a system of self-cleansing sewers. Instead of taking the earth to the manure, it is the cheapest to take the manure to the earth, and to prepare the earth *in situ* for its reception. In the instances of detached cottages in rural districts unconnected with any general water supply, or with any systematised means for the removal of the waste water, a simple glazed earthen vessel under a seat in the outhouse, or a common tin pail with water, or better, with the house slops and soapsuds also in it, is a more ready and better provision.

Objections to.

Taking the manure to the earth.

Assuming that a garden is attached to the dwelling, the cottager should be taught to keep a portion of it trenched two spits deep, and to deposit regularly every day the liquefied manure in as much of the trench as it will immediately absorb. The day's deposit should be covered at once, to "save the manure" from loss by evaporation and decomposition; and a far larger portion of soil may thus be more readily and completely fertilised than by any manipulation of solid manures. The trench should be in the direction of the roots of trees or of growing crops. In the Swedish annexe, and also in the Danish annexe, there are

well contrived pails with seats, and with interior divisions to receive and keep separately the urine and the more solid fœcal matter. This may do very well where there is special agricultural or horticultural preparation for the treatment of the manures, separately and immediately. But this is rarely the case. Moreover, it is the result of much observation that the miscellaneous manures—liquefied—soapsuds, and the other house refuse, which can be removed in suspension, and the very miscellaneous manures of most towns, act better for most vegetables than any single manure. In the case of *cités ouvrières*, or detached houses, where they may be no sufficient means for the regular application of the manure near the houses, or it may be beyond individual attention, it should, as a commencement, be made the subject of a distinct regular service by the collection and the daily removal of the refuse in proper water carts or tanks.

Failure of cabinets inodores.

I shall not be supposed to countenance the system of the movable cabinets "inodores," so-called, which are being abandoned in the Continental cities. The great sanitary object, and the minor agricultural object to be kept in view is to have all matters removed before they enter into advanced stages of decomposition. This system of the *fosses inodores* attempts to retain such refuse after it has entered into those stages, and to confine the products, which it never does, until a late removal. All fixed cisterns or fosses of stagnant refuse are magazines of poison. It is matter of surprise that, with such unity of power and with such very distinguished administrative ability as there is in Paris, the system of fixed fosses should be allowed so long to remain, to the deterioration of its superior atmosphere to an extent that, in the summer time, often makes the houses in the best quarters uninhabitable, and that, too, at a cost to contracting companies for intermittent and offensive cleansing that, if capitalised and duly applied, would suffice for the complete removal of the evil.

Fever nests, how made.

Application of sewage

In respect to the question of the application of excreta as manure, which is made to govern the internal household arrangements for its removal, I had, in the course of the International Exhibition of 1856, and as one of the international jury on hygiène, the honour of an audience with the Emperor, at which I directed his attention to the subject of the application of sewage to agricultural production. I submitted to him the expediency of having trial works made upon the question by his own officers for the public information. He was pleased to give directions to that effect; and the trials of the productive power of sewage or of liquefied manure were made, chiefly under the direction

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of Professor Moll, of the Conservatoire des Arts et Métiers, one of the most able scientific agriculturists of Europe, aided by Mons. Mille, the Engineer-in-chief to the municipality of Paris. I may say that the trials they conducted were becoming their positions, and were the most comprehensive, with different forms of culture, and the best and most complete public trials that have been anywhere conducted. The results of later and extended trial works on a farm may be seen stated and the principles expounded in the "Annales du Conservatoire Impérial des Arts et Métiers," by M. Moll, in a paper entitled "L'Assainissement des Villes, par la fertilisation des Campagnes." It must be said, however, that all the trials were conducted with sewage from the fosses, which is old and putrid, instead of with sewage which is fresh; for sewage which is fresh and unwasted by decomposition would be difficult to obtain in Paris, or anywhere else—except in a district which is drained by tubular self-cleansing drains and sewers. It marks the little progress made in the diffusion of sanitary science that it should be yet commonly conceived that sewage is all of one quality only, that found in all towns; that there is yet little conception of the difference there is between sewage which is old and putrid and sewage which is new and fresh; that it should be known that sewage which is old has one third less fertilising power, and at the same time requires above a third more of deodorising or disinfecting agents than sewage which is fresh. Though sewage should be put to more profitable use than feeding fish, it may be proper to mention, as a point of progress since the last Exhibition, that it is now found that where sewage is conveyed through systems of self-cleansing tubular house-drains and sewers direct from the house to the river, instead of killing fish it feeds them. Anglers find their best sport, and catch the largest fish at the mouths of sewers which discharge sewage that is fresh. At the last Exhibition the attention of the Emperor was directed to the example of the distribution of sewage by pipes and jets at Rugby. Since then Mr. James Blackburn, the agricultural engineer, has demonstrated in the distribution of the manure of the camp at Aldershott, that by enlarging the size of the pipes, and a better application of engine power, sewage may be distributed at about half the expenses at Rugby, or within a half-penny per ton. It is further demonstrated that sewage may now be utilised on one third the area than commonly considered to be requisite for the purpose. On experience of the application of the less putrid sewage of Aldershott camp, Mr. Blackburn concurs in the general

Trial works in Paris.

Difference between old and fresh sewage.

statement, that with active garden cultivation, the land being well trenched, and the liquefied manure being applied in appropriate doses, the sewage of a family of five persons may be utilised on an eighth or a tenth of an acre of land; so that the day's sewage may be utilised on a plot of land four feet square, or even on a yard square if worked two feet deep. On such trials and estimates, the sewage of the million of inhabitants of Paris proper may, by high cultivation, be utilised in 20,000 acres, or on an area of $5\frac{1}{2}$ miles by 6 miles, or the sewage of the three millions of inhabitants of London on 60,000 acres, or an area of ten square miles.

Extent of land requisite for the utilisation of sewage.

In the Exhibition and the annexe there is a display of varied manufactures of hose pipe and of distributing apparatus which marks the extension of the system. In a paper upon it, printed in 1852, I proposed the distribution of liquefied manure by movable carriers with *lateral* apertures. This has not yet got into practice in England; but it has been adopted in France, and it may be seen applied for the distribution of water in the Bois de Boulogne.

In the report on the water supply of the metropolis (1850) the results of some trial works were given, with woodcut illustrations, showing that, by means of flexible hose pipe, on rollers, paved surfaces might be kept washed as clean as a paved courtyard, and the roadway watered at an expense not exceeding a halfpenny per head per week of the population—a means of a great economy of washing and the wear and tear of clothes, as well as of personal and household cleanliness. The conditions of the trading water companies and of our local administrations have not been sufficiently advanced for the adoption of the plan in England; but it may be seen at work in the chief thoroughfares of Paris, in watering the roads and keeping down the dust, to the great relief and comfort of the occupiers of houses as well as of passengers.

Cost of washing the fronts of dwellings.

With an ample vote of money and a given style, it is very easy to assemble a staff of architects competent to construct a palace or any great first-class edifice; but it is one of the problems of the day to construct, with the necessary rigid economies and with the proper sanitary qualities, a cottage or pattern dwelling for the many—the poor. Here in Paris we have the example of the greatest power animated by beneficent intentions, having at its command the highest architectural art and science, which has superbly rebuilt cities with the most splendid of modern edifices, and has yet left the habitations of the many with walls absorbing damp and

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mephitism, and in a condition to continue to be fever nests and to harbour the Egyptian plague of vermin. What I humbly submit to power, to avert this state of things, is that the extension of the existing improvements, and their advancement in economy as well as in other desirable qualities, would be greatly aided by authentic public trial works of different materials available for construction, not merely as to strength and bearing power, but in impermeability to moisture, and washability, and their powers as non-conductors of heat and sound. Neither individual proprietors nor common builders have the time or the means to determine these questions; nor are they to be expected to move in them at their own individual expense for the common gain. Advances in economy, with improvements in quality, can only be promoted extensively by applications of capital, on the scale of a manufacture of such dwellings with the advantages of large quantities, or of repetitions of large numbers by machinery. Some parts—woodwork, doors, windows, and flooring—are now produced by machinery, but separately, and the subdivision of labour only entails at present, it is stated, a multiplication of the separate trade profits. What appears to be now wanted for economy is complete manufactures under one head. And, on the manufacturing principle of repetitions, the cost of good first moulds, when spread over large numbers, will be inconsiderable; and some relief from the common repulsive forms may be expected to be given by a chaste and appropriate interior (and washable) as well as exterior art decoration, for which there are symptoms of a rising perception and desire on the part of the wage classes. The objection of a common contractor or a common builder to the introduction of any improvement in detail—to the introduction of an improved cooking range, or an improved window, for example, or to any sort of ornamentation—is, usually, that it cannot be introduced except at a certain price—namely, at his retail trade price of 20, 30, or 40 per cent. of profit on the cost of production—making up a charge which is prohibitory. It is important to observe that the majority of the examples of extensive improvements represented in the Exhibition are examples achieved by associated individuals or companies, such as that of Mulhouse, under highly intelligent and zealous direction. Such associated effort,—or the individual efforts of intelligent large owners,—must be looked to for the best improvement under such direction as will not accept existing habits and practice of construction as fixed and unchangeable conditions (as most associated building companies in England have hitherto done), and as will set

Course of improvement.

Associated non-trading effort necessary.

aside obstructive interests, and will be content with wholesale profits, such as 10 per cent. upon materials obtained first hand, or manufactured expressly on a large scale.

Collective improvements practicable.

On the whole, viewing collectively the various models and collateral appliances presented for examination in the present Exhibition, there will be found in it the means of very important advances in the improvement of the dwellings of the great mass of the people—in the means of relieving them from the cesspool smell, or the bad drain or sewer emanations and smell; from the foul wall smell and from the wall vermin; from the damp wall; from the smoke nuisance; from a great proportion of the waste of fuel and the loss of heat; from stagnant and vitiated air; from the deterioration of good water supplies; from much of the exclusion from sunlight, and it is proved that by new appliances their dwellings may be made cooler in summer and warmer in winter; and that too, not only without any increase but with a very material reduction of direct expense. I say of direct expense, because, when the losses from excessive sickness, premature disability, and premature mortality are taken into account, a great proportion of the common dwellings of the wage classes, though they may be cheap to construct, are indirectly and eventually dear to use. By dwellings with the improvements specified, the rates for insurances against sickness, disability, and mortality would be reduced nearly one half. With clean, light, bright, warm, comfortable, and healthful dwellings; with the habits of personal cleanliness, sobriety, and frugality,—to which such conditions would conduce,—new and improved populations would arise. To one accustomed to inspect town schools in the lower districts, the comparative condition, external as well as internal, of the dwellings may, to a considerable extent be inferred by the comparative aspect and condition of the children. Already, in neighbourhoods where partial sanitary improvements have been made for a few years, school teachers mark an improvement in the condition and quality of the children received from them, who are less squalid, less ugly and less vicious, and more apt for instruction. It is now generally admitted, by all who have attended to the subject, that moral and social advancement is dependent on physical improvement, and that on the sanitary improvement of dwellings.

Displayed in the rising generation.

## Report on Articles of all Kinds manufactured by Skilled Workmen—(Class 94.)—By Blanchard Jerrold, Esq.



The tenth group is a new feature in exhibitions of industry. We are officially told that it comprehends "the "whole series of objects exhibited with the special view of "furnishing the rural and urban populations with the means "of improving their physical and moral condition." I pass by the classes which comprehend popular education, cheap food, clothing, lodging, and household management, and come to—

Novelty of the tenth group.

Class 94. Articles of all kinds manufactured by skilled workmen.

Class 95. Instruments and modes of work peculiar to skilled workmen.

The former class is represented in the catalogue by 486 French exhibitors, 18 Prussian, 3 Hessian, 10 Austrian, 7 Greek, and 1 British colonial.

The latter class consists exclusively of French exhibitors, who are thirty-two in number.

The exhibitors who are described in the catalogue as appearing in Class 94 do not, in many cases, belong to it. Strictly speaking, half the exhibition might be brought within this class, if its range were admitted to be that which some exhibitors have given it; and, indeed, which the authorities appear, in some instances, to have adopted. The main object of this class was to show the work of artisans who labour on their own account, either alone or with the assistance of their families, or with one apprentice—for a trade or for domestic consumption. The purpose to be served was excellent. M. Jules Simon, Audiganne, and other French writers have dwelt of late years on the destruction of the family by machinery, which has drawn father, mother, and children from the fireside to be brigaded in different mills and factories. According to M. Jules Simon, in those districts where machinery has supplanted entirely home labour, there has followed an increase of drunkenness and immorality.

Main object of Class 94.

The first impression that is made by an examination of the court of skilled workmen, situated in the French section, at its junction with the Algerian section, is, that the tendency of every trade, save and except those which may be generally described as the minor trades of the *Articles Paris*, is towards large workshops. Indeed, it is difficult, as this Exhibition

France.

Mr. Jerrold on Articles made by Skilled Workmen.

proves, to find enough skilled workmen working on their own account, or working apart with the help of their family or an apprentice for their trade, to make an important show.

The skilled works which are ranged under Class 94, in the French section, consist of bronzes, art-work in metal, ivory-turning, wood carving and carpenter's work, toys, mechanical and scientific engineering, and other models, including an ingenious calculating-machine by L. Chemar, and a small variety of clever inventions. The most notable skilled industries of Paris represented in the court are bronze and works in wood. There is some excellent brass and steel work. J. Mathieu exhibits some accurate, delicate, and gracefully-designed ivory-turning. There are a few *tours de force*—as A. Panon's dwarf fiddle, weighing 25 centigrammes, an instrument that might be useful in Liliput. There are, moreover, some exhibits that are mere monuments of patience, as Mdme. Douil's woolwork, which pictorially describes the marriage of the Emperor and Empress. M. Chriten's cross of honour, carved in a single agate, is a highly skilful bit of labour. The two industries, I repeat, which make the important features of Class 94, in the French section, are the bronze and the wood work. The works in bronze which are exhibited in the main central case are nearly all well known and already rewarded trophies of the Paris bronze-workers' highest skill. Barye's fine group, inspired—as many sculptors have been—by the struggle of the Lapithæ and the Centaurs, cast in bronze by Boyer; Poux's works, which have gained the highest prizes at the competitive exhibitions of the bronze manufactures; Gonon's rough cast of a bird's-nest, and his finished bronze, are excellent samples of the vigour, the finish, and, at the same time the delicacy which characterise the work of the foremost bronze modellers and casters of Paris.

Works in bronze.

Woodwork.

In woodwork there are one or two of those great models of fine timber-work which the carpenters and cabinetmakers of France have delighted to carry in their processions for centuries, and which have caused so many lively contests of skill since the old freemasonry of labour split into two factions—the Gavots and the Devoirants—under the towers of Orleans Cathedral, four centuries ago. Over these trophies many savage quarrels have happened. The two latest monuments of skill, which are in the skilled-labour court, are exhibited by the journeymen of the Devoir and the journeymen Passants. They are fine examples of the skill and knowledge of the leading carpenters of Paris. That of the Devoirants—a temple, dedicated to Solomon— was completed in the present year. The intention of the framers of

Class 94 was undoubtedly to illustrate the skill obtained by independent workmen, or workmen taking contracts from manufacturers and working apart with their families, or with apprentices, or with the help of one or two men. I repeat that the bronze-workers and the workers in wood, the carpenters and cabinetmakers, furnish the most important illustrations of the effects of the small-workshop system as opposed to the factory system. The Paris Chamber of Commerce, in the first report issued under their authority on the industries of Paris, having divided the group of industries, which include every kind of art-furniture, paperhangings, bronzes, and cabinet-work into thirty-two sections, placed the bronze trade at the head of them. These thirty-two sections, it will be seen, comprehend all the notable art-industries for which Paris is famous. The bronze-workers of Paris still command the markets of the world, if not always because their works are artistically superior to ours, because we cannot produce them at anything like the Paris price. The system of labour by which the Paris bronzes are produced is that of dealing through overseers with skilled mechanics, who employ one or more journeymen or apprentices. It is this system which prevails in the leading trades of Paris, but is very slowly giving way to collective labour in great factories, like that of M. Barbédienne, the celebrated bronze manufacturer and worker of the Collas patent, and M. Boy, the great imitation bronze manufacturer in the Marais. In order to justly appreciate the value of the works exhibited under this class, is is necessary to get some experience of the *grand atelier* system, as opposed to the *petit.* Examples of the work sent forth by independent skilled workmen are to be found, indeed, scattered over the first three groups of the Exhibition, and more particularly in Classes 8, 10, 12, 17, 20, 26, 34, 35, and 39. Then there are some few articles of skilled manufacture which belong to the fifth and sixth groups—carpenters' work, for instance. Agriculture, again, presents, in groups 7, 8, and 9, examples of home or independent labour. It has not, however, been found practicable to bring this vast variety of products from every nook and corner of the Exhibition into a great court of independent skilled labour. Nor indeed would any very useful purpose have been served by such an assemblage, unless the authorities had been prepared to institute at the same time a searching inquiry into the relative results of the rival systems of great and home workshops in every country. As it is, Class 94 affords an opportunity of comparing the *grand atelier* system with the *petit atelier* system of Paris. The insignificent exhibits of Prussia, Austria,

Bronze industry of Paris.

Home and factory systems

Compared.

Mr. Jerrold on Articles made by skilled Workmen.

Hesse, and Greece can give us no idea of the value of the home system of manufacture in any of these countries. J. Carvellas sends a bracelet cut in apricot kernels, from Zante; and at hand are a crook and bagpipes of home manufacture. There is some fair morocco-work and amber cigar tubes, and brushes from Austria. The collecve exhibition of industrial articles from the Industrial Society, of Hermanstadt, in Transylvania, does not properly belong to Class 94. The brown cloth for the national costume by M. Basak is a good home-spun fabric; but, in order to test its value as a cheap material for the costumer, and as affording fair remuneration to the producer (and in this light only does it belong to Class 94), it would be necessary to make a serious inquiry, such as I have indicated, into the relative merits of the great factory and home factory systems as they appear in Austria.

*Petit atelier*, or home system.

The *petit atelier*, or, as I will call it, the home system, as opposed to the factory system, in Paris, appears advantageously in the bronze trade, as contrasted with the trades of the workers in wood. The home system has a tendency to degenerate into what we understand by, and deplore as, the sweating system. If the home system could be kept within the bounds those social economists would strictly assign it who set a high value upon the promotion of the domestic virtues among the working population in a State, it would be, I think, beyond all question, the best system for the workman and his family. But competition, widened by free trade, has sharpened the wit of manufacturers, and driven them in quest of the cheapest modes of production. They have, inevitably, recourse to every possible subdivision of labour. The son of the great art workman, who could execute perfectly every part of the most elaborate cabinet, becomes the mechanical fashioner of a chair-leg. This subdivision of labour necessitates the close congregation of the labourers. The sweater is making havoc among the cabinetmakers of Paris, who are the descendants of André Boule and Riesner. Great quantities of manufactures are cheaply produced; but, I take the Paris cabinetmakers' own statement, the skilled art workman is disappearing. In this trade the home system has merged into the sweating system. A skilled workman gets materials from a patron, and employs a clumsy journeyman or two and apprentices at something like starvation wages. In nearly every Paris trade the sweater has made his appearance, and he operates most disastrously for the workman when he finds him at home. The complaints of such skilled art workmen as the engravers for textile fabrics and paper-hangings are to the effect that

Subdivision of labour and sweating system.

the men who trade in designs—who stand between them and the manufacturers who want designs—are continually driving down their already scanty wages. In the case of the bronze workers, men of extraordinary skill command, as in any other trade, exceptionally high wages. But I found, on close inquiry, a short time ago, that the wages of 80 per cent. of the bronze workers of Paris did not exceed 3*s.* 7*d.* per diem, and that only 5 per cent. exceeded 5*s.*

Wages.

The skilled workmen who employ one or more men and take rough castings from manufacturers are, I apprehend, in the last category, and pay the lowest wages in the trade. A glance at M. Boy's imitation or zinc-bronze factory, in the Rue Saint Louis, and at the *grand atelier* system as herein developed, will afford a favourable contrast between the home and factory systems as they regard the bronze trade. In this establishment there is a minute subdivision of labour that indubitably tends to the growth of an inferior race of workmen. One man can only lay on the vert antique; another passes his days at a little fire soldering zinc arms to zinc trunks. Each man, of course, acquires marvellous dexterity and rapidity. The race is for cheap production, and time is a main element of cheapness in this imitation work, for the material makes a great part of the price. It is stated, however, that these comparatively mechanical workers in imitation bronze earn, taking the good with the indifferent workman, an average of 7*f.* a day. This is an employer's statement, which, I am bound to observe, is contradicted by the delegates who represented the Paris bronze trade in the Exhibition of 1862. On the one hand, the workmen point to the dull season; on the other, the masters blame the men, who will only work, even in the brisk season, four or five days in the week. M. Open (who exhibits a spirited and finished bronze representing two birds fighting, and who calls himself an independent workman, employing others) has stated to me that the average wage of his employed men is 6*f.* a day, and that the work he undertakes is of the finest quality.

*Grand atelier*, or factory system.

Wages.

In the Paris carpenters' trade there are great and bitter dissensions. This trade is divided broadly into two classes—the menuisier, who may be described as the maker of small articles; and the charpentier, who is a builder in timber—a house carpenter. There are sub-divisions of the menuisiers and the charpentiers; but into these it is not necessary to enter. In all branches of this trade we find the home or small workshop system in force, and it appears to have been degraded to a very aggravated form of the *marchandage* or middle-man system. The disputes between the skilled and

Carpenters' trade in Paris.

Mr. Jerrold on Articles made by Skilled Workmen.

crafty carpenters who take petty sub-contracts and fulfil them by paying bad wages to clumsy country journeymen and apprentices are incessant. The ever-increasing use of iron in building operations has aggravated the hardships which the sub-contract system has produced among the Paris carpenters. The woodcarvers of Paris, who chiefly work in shops, and therefore exhibit little or nothing in Class 94, are an independent, highly-paid race—that is, those among them who can produce any of that delicate work in wood for which Paris is famous, and besides which the Swiss carving is coarse and unnatural. The carvers may be parted into those who work on chestnut and the close and fine grain of the pear-tree and the mechanical carvers in coarser woods. The highest rate of pay is about 6*s.* for a day's work of eight hours, while 3*s.* 4*d.* is the lowest. The men who are employed in the vast cheap carved furniture trade, and are on a level with M. Boy's piecemeal workmen, complain of the *marchandage* system which is now carried on in the little workshops, and which, in point of fact, Class 94 represents. The clever sculptor in wood, when he has once managed to rent a shed and a back yard, takes a quantity of contract work from a firm, and performs it by getting low-priced inferior workmen in his pay. The most cunning plan appears to be to employ a shopful of apprentices, and to teach each one only the art of fashioning one ornament.

Wood-carvers.

A. de Sorbet, Rounay, and Company, of the Faubourg St. Antoine, exhibit in this class a little not remarkably good cabinet-work. The firm describe themselves as a Société Ouvrière, and in their prospectus distinctly state that they have opened workshops where all their goods are manufactured. They add that the workmen share in the profits of the business, an intimation that gives some interest to their exhibit; but since their cabinet-work is produced in a factory it ceases to belong to Class 94. Many exhibitors who are printed under this class, both in the English and French official catalogues, entirely repudiate any connection with it. Many printed under Class 94 actually appear in Class 91. There are in the list of exhibitors under this class many well-known Paris and provincial firms who do not exhibit under it, and would, indeed, appear ridiculous in it. For instance, Messrs. Mazaroz-Riballier and Co., upholsterers, repudiate the least connection with either Classes 94 or 95. Among skilled workmen working on their own account I find the Count de Boissimon, who exhibits (but not in Class 94 at all) "artistic, household, and earthen and other ware; fire-brick, flooring, and other tiles." Indeed, the greater part of the list consists of names of great whole-

Errors in the catalogue of Class 94.

sale and retail Paris houses, who appear in all kinds of groups and classes save group 10, and Classes 94 and 95. The list is swollen with a number of collected exhibitions, as those of the Chamber of Commerce of Elbœuf, the towns of Sédan, Saint-Quentin, Rouen, Mulhouse (the charities and provident societies of which are worth the personal study of every student of social science), Troyes, Rheims, Vienne, (Isère), Mazamet, Limoges, Tourcoing, Lodère, Bedarieux, Lisieux, Lille, Cholet, &c. But, I must repeat, not any of these exhibits are in class 94, except in the catalogue. Undoubtedly the French skilled workmen show "increased finish "in the execution of works of art in bronze; variety and "judicious selection of models, in the manufacture of fancy "articles, the improvement of certain musical instruments, "of new tools, apparatus or implements for certain manu-"factures, ingenious applications of electricity; and, lastly, "interesting inventions, in accordance with the programme "of the Imperial Commission, relating to the physical and "moral condition of the working classes." But these improvements, inventions, instruments, and articles have been already treated of by the reporters on the classes under which they are respectively exhibited.

Bronze trade machinery.

The bronze trade represents in a more striking manner than any other trade the two rival systems of art-industry in Paris. Machinery has had no influence on the trade of late years. The Collas machine, for the mechanical production of reductions, is the only mechanical worker that has raised the ire of the bronze-workers. If, then, they have suffered reductions of wages of late years, it is not because a mechanical force has been brought into competition with human skill and strength. M. Open, who exhibits as an independent workman employing fellow-workmen, and is a bronze chiseller of mark himself, returns the average wages of the men he employs at 6f. per diem. So that we do not find at present that men working in small shops earn more than men working in great factories like Barbédienne's or Boy's. The preparations among the bronze-workers for this Exhibition, however, presented an incident in which the small atelier shows an advantage over the factory. The factory directors (I need not mention names), as usual, were behindhand with the works they intended to exhibit, and consequently had to insist upon over-work. Their workmen struck for higher wages and obtained them, but not until after the manufacturers had been put to great inconvenience. While there was a strike in the great workshops the little workshops remained busy.

Strikes.

M. Poux.

M. Poux, whose works are perhaps the finest examples of

Mr. Jerrold on Articles made by Skilled Workmen.

finished bronze exhibited in this class, is a good example of the highest skilled workman who is an employer of labour also. He is famous among chasers for the marvellous skill with which he renders the texture of the human flesh. The examples of his skill which are in this court are remarkable chiefly for the perfection of "le chairage." He is the art workman who is employed by leading bronze manufacturers, like Lerolle and Barbédienne, whenever highly delicate anatomical modelling and chasing are required. Such workmen have become rare in Paris, for this reason, that directly a bronze worker or chaser makes a reputation he drops the chisel and takes to the more remunerative art of modelling. So general is this course that it has become an accepted dictum that only the dull and defective remain bronze-chasers. "Bête comme un ciseleur" is a French proverb. M. Poux, however, has stuck to his chisel, and has set up a small workshop, where he employs from eight to 20 workmen. According to him, chasers employed in the great factories earned, on an average, between 4f. and 5f. a day, before the recent strike; whereas they now earn between 6f. and 7f. for a day's work of ten hours. Most skilled men in this trade can work, if they please, at home. During the busy season many prefer to work under their own roof; but during the dead season they return to the workshops of the great manufacturer, who can generally find employment for them, on preparatory works for the next season. M. Poux adds that he is never without work. There is a great desire among the leading skilled bronze workers of Paris to try their fortunes in England, created by the renown of M. Vechte and others. The masters of little workshops maintain that independent art workmen and those who are employed by masters who are themselves workmen, produce the best bronzes. They are not tied down by hard factory rules; they are not the slaves of a bell. They are free to work when inclination prompts them; and therefore they work with something like inspiration—at least, with earnestness.

Wages and conditions of labour.

Models, &c.

Included in this class are some interesting models and ingenious contrivances—little monuments of workmen's patience and intelligence. They illustrate no system of abour. They are hobbies of earnest and exceptionally patient and intelligent working men. M. Barat exhibits the model of a locomotive. He is not a working engineer; he was, during 18 years, a railway employé, and is now co-manager with his wife of a shirtmaking business. This highly finished, compact, and well-adjusted model occupied the leisure hours, chiefly stolen from the night, of 12 years.

M. Barat exhibited the movement of a similar engine in 1855, and received the compliments of Mr. Crampton. The model locomotive now on view may be at any time examined by engineers. M. Margotin exhibits two inventions by M. G. Monot—viz., his universal horarium and his chronometrical planisphere. The horarium—it may be a watch, or a chronometer, or a clock—indicates at a glance the hour in every part of the world. By this invention, M. Margotin explains, everybody may carry in his pocket the actual hour in any latitude. He takes a sentimental view of the planisphere, saying, "Those who have an absent dear one, may "tell by it at any moment when he or she is rising or going "to bed." The presse-papier is also an ingenious and elegant novelty. M. Philarète Chasles advised M. Margotin to make these clocks cheap, so as to be able to sell them at schools. Their educational value is no doubt appreciated in Class 88, where they are also exhibited. M. Margotin's chronometrical planisphere, which tells the position of the moon and stars in relation to the earth, is exceedingly simple and ingenious, and has been received by the Academy of Sciences. I may add that the single clocks can be made for 1*l.* An interesting fact about M. Margotin is that, as a workman, he was led to the study of astronomy by a translation of James Ferguson's works, which he found in the Imperial library.

M. Battaille exhibits in this class a beautifully finished model of a country-house, on which he has spent the leisure hours of 25 years. It is, indeed, a miniature palace. The brass and steel work of the balustrades and candelabra; the marqueterie, the mosaic work, are all highly finished, and display wonderful taste in the selection of material. The imitation mosaic carpet in the salon is a rich bit of minute art-work. Every description of costly wood has been used. The model contains 13 rooms, and each room is a separate and charming study. It is covered by a roof composed of 6,000 little tiles carved in wood. It is a trophy of patience and of highly cultivated taste; but, strictly speaking, it does not belong to Class 94.

## Report on Instruments and Modes of Work peculiar to Skilled Workmen.—(Class 95.)—By Blanchard Jerrold, Esq.



It was intended by the Imperial Commissioners that this class should comprehend: 1, the instruments and processes (enumerated in the sixth group) habitually employed by workmen acting on their own account, or specially adapted to the demand of industries carried on in the midst of a family or at home; 2, the manual labours which exhibit, in the most remarkable manner, the taste, the dexterity, or the perseverance of the artizan; 3, those industries which, from various causes, have best withstood to the present time the introduction of machinery. The object of forming this class was, we are further told, to bring to light those productions in which skill forms an essential ingredient, and which require a spontaneity and artistic sentiment of which man alone is capable. The exhibits of this class were to make known new and ingenious processes, and to prove highly advantageous to working-men, as offering them the opportunity of study and selection amidst "a well-arranged series "of productions and methods, and to awaken within them, "perhaps, capabilities of which they did not believe themselves possessed." This class was, moreover, to prove a revelation of processes that might be carried on at home or in small workshops. Many trades were necessarily excluded on account of their unsightliness or unwholesomeness, or, again, of their slow development. The exhibits actually grouped under this class are all French, and are thirty-two in number. Workmen and workwomen carry forward and complete many industrial processes, under the public eye, in that part of the French section of the great machinery gallery which borders on the Algerian section. Indeed, within the square set aside for Class 95, are some picturesque Arabs embroidering slippers, cutting corks; and in two exceedingly picturesque, well-disposed corners are Ali Ben Mohammed, of Algiers, embroidering purses and slippers, and two jewellers from Tlemcen working delicate silver filigree-work, with a few tools and a little charcoal fire. Native work—amusing and pleasant to the artist's eye, but not socially instructive to the workman and manufacturer—goes forward daily in the Egyptian Bazaar in the park. The Commissioners admit, in their prefatory notice to this class, that their idea has been only partially realized. They

Intended exhibits of the class.

Actual exhibits.

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acknowledge that they could find only a few independent skilled workmen who could command the means so to instal themselves in the Exhibition as to present to the public an exact reproduction of the methods, processes, and tools of their home workshop. They were compelled to call some manufacturers to the rescue who would agree to exhibit their manufacturing processes, and at the same time give to their workmen employed all the honours which the juries might deem the fair reward of their skill. By this combination the following industries have been got together under Class 95:—Engraving on metal, glass, mosaic work, glass-blowing, optical glasswork, composition and printing, furniture-carving, the manufacture of pocket-books, baskets, ivory and horn combs, hats, fans, feathers, flowers, and various small wares, enamelling, precious and hard stones, shells, shawl-designing, artistic beadwork, embroidery, lace and trimming making, diamond cutting and polishing, hairwork, and imitation jewellery.

There may be much that is striking to the unitiated in these exhibits, which discover to them the skilful flower-maker fashioning roses and violets with her little pincers; the cameo-cutter at his minute work; the workers of the commonest imitation jewellery, making trinkets by the bushel; glass-blowing and engraving; the pasting and contriving of porte-monnaies and pocket-books; the laceworkers at their cushions, and M. Dupont's female compositors handling the composing-stick; and the manufacture of screw-boots and of felt hats. But I cannot find any new tools that are employed in these exhibits, nor the revelation of any process that is not familiar to every follower of the trade in which it is employed.

Absence of novelty in the exhibits.

Industries carried on in the French section.

The three or four specially interesting industries that are carried on under Class 95, in the French section, are the manufacture chiefly of felt hats by Haas, and the making of silk hats by the associated working hatmakers of Paris; the lace manufacture by Lefebure; the lens grinding and polishing of Lemaire; the ivory-turning of the Maison Moreau; the hair net-making of Girard-Thibault; the fine and delicate gold embroidery executed by Dupuis and Co's workwomen; the wood carvers; the comb-cutting by machinery of E. Casella; and M. Bernard's diamond-cutting. There are some other pretty exhibitions of dainty work. The glass-engraver at his delicate labour, the girls twisting columns of glass over a blowpipe into branches of flowers, the imitation-pearl blowing, and the rapid manufacture of common fans are amusing and instructive to the general visitor, as the manufacture of screwed boots unquestionably is. But it is

impossible to maintain that the new felting machine, or the process which is carried on—much of it by machinery—by the workmen of M. Haas, is anything like home work, or labour which a skilled workman could carry on with the help of one or two paid associates. Nor is the manufacture of screw boots by machinery an industry which a skilled workman could compass with the help of a few apprentices, or in his family. Moreover, the manufacture of screw-boots, which necessitates complicated and expensive machinery, does not come fairly within Class 95. The Exhibition includes a revelation in bootmaking which has astonished and perplexed all the authorities in the trade from Mr. Sparkes Hall downwards. Among the English exhibits of boots is one by Mr. Glew. He shows at the bottom of his case some boots, the soles of which have been sewn on, and solidly and neatly sewn on too, by machinery. For years the bootmakers have been endeavouring to contrive a machine that would sew the sole to the upper leather. The difficulty has been solved at length; but nobody has been able, down to the present time, to get even a peep at the machine. It is not in the Exhibition. Its appearance would have created great curiosity and commotion in the boot trade; whereas the French exhibits of screw-boot making affords no new knowledge to the bootmaker. I cannot part from this subject without remarking that, after a minute examination of all the boot and shoe manufacturers in the Exhibition, leading authorities in the trade have agreed that the best handwork in the building is in the case of George Player, of George-street, Euston-road. Every boot and shoe in his exhibit is the work of his own hands; and he boasts that he is the only workman who ever received an international prize medal. He should have been included in Class 94, for he is a working-man who not only fairly and honestly presents for competitive examination the work of his own hands, but this work is admitted by competent authorities to be better than any shown by great manufacturers.

England. Boots soled by machinery.

M. Lemaire's is an interesting exhibit; but it is that of an important manufacturer who employs about 150 workmen. M. Lemaire is the inventor of a new and most ingenious labour-saving machine for grinding and polishing lenses. This machine, which is at work in the French gallery, polishes seven glasses at the same time. The manual labour saved is immense, since one man can attend to ten of these steam-driven machines, which have now been in use abou six months. There is very little home-work in this trade. The workman is paid by the piece, and his average wages

France. Lens grinding and polishing machine.

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are 5½ f. for a day of twelve hours. M. Lemaire's factory is specially interesting as showing the care of the employer for the employed. It includes a schoolmaster, who is ready to teach all who may desire to learn, and the roof of the factory has been arranged as a walk, or recreation ground, in the most ingenious manner.

Lace industry.

The lace industry of France employs, it has been officially estimated, 240,000 women, of whom nearly 60,000 are to be found in Normandy alone. The point-lace workers of Alençon and Bayeux work in great ateliers. M. Lefébure, whose workwomen are in the French 95th class has opened special workshops at Bayeux, in order, he says, to break through the old prejudices of the isolated workwomen, and to get new effects of light and shade by an intelligent variation of the net that fills the flowers. A dress of this improved lace is exhibited in Class 33. One of the lacemakers who is seen at work, works all the Alençon points; but the rule is to have a different workwoman for each point, and there are twelve or fourteen varieties. Two or three years' apprenticeship is necessary to obtain fair skill in this work. The Alençon lacemaker earns from one to two shillings per day.

Black lace.

Black lace making is a much more important industry, and is the resource of the wives and daughters of agricultural labourers in Lower Normandy. This delicate and difficult industry has not been yet aided by machinery, even for the preparation of the cards. The card pricking is an operation that requires so much patience and regularity that many who begin to learn it are driven away from it by its tedium. M. Lefébure has educated girls to do this part of the work, which has hitherto been generally accomplished by men. The visitor will see at a glance, by watching the three women at this lacemaking, the use of the card. This industry is, as carried on in Lower Normandy, for instance, essentially a home one. At the age of five and six the little girls of the Norman villages begin to learn the art of lacemaking. When they grow up, and become mothers, the lacemaking occupies them profitably while the husband is at work in the fields. They can leave it at any moment, as in the harvest time, when they, too, work in the fields. It is difficult to get at the average earnings of a Norman peasant women by lacemaking, but an ordinary day's work may be safely said to produce a shilling to the workwoman.

Hair ornaments.

Near the laceworkers are the makers of hair ornaments, who appear under the wing of Beaufour, Lemonnier, and Girard-Thibault. The former firm make hair ornaments mounted in gold, as jewellery; and the latter fashion hair-

nets. M. Lemonnier's workmen and workwomen carry on their trade in his workshop. The trade is chiefly in the hands of women, whose wages vary between two and four francs per diem. The only men employed are special art-workmen in the trade, who earn from eight to ten francs a day.

Hair-nets.

The hair-net trade, represented by three workmen in the employ of M. Girard-Thibault, has increased enormously of late years. It is estimated that there are now 15,000 women and girls employed in it in France. Nets made by machinery are, of course, much cheaper than those made by hand. To the present time, the result of the introduction of machinery into this trade has been beneficial to the makers of nets by hand. The argument is that machine-made nets have created a taste for hair-nets. The cheap machine-made net is found to be frail and bad, and then the wearer casts it aside and buys the more durable, if dearer, hand-made net. Thus machinery has stimulated the employment of female manual labour in the provinces as well as in Paris. The country net or mitten maker earns about 10*d.* a day, and the Parisian workwoman can make 2*s.* A great export trade in hair-nets, mittens, &c., from France to England and to distant places—to Havannah, Chili, Brazil—has arisen of late years. The house to which the three workwomen in Class 95 belong employs more than fifteen hundred hands, and there are fifteen hair-net manufacturing houses in Paris.

Ivory turning.

Ivory-turning is carried on, as a rule, in great and not in little workshops. Steam is employed only in the very large factories. Most of the machinery is worked by the hand or by the foot. There are a few ivory-turners who work independently under their own roof. A firm that employs from twelve to fifteen ivory-turners, as the exhibiting house of M. Moreau, must have a large trade. The work which this house produces, and which is to be seen in progress, is the turning of billiard-balls and the carving of little ornamental objects. The wages for ordinary workmen are between 3*s.* 6*d.* and 5*s.* a day. Of course the highly-skilled artistic sculptors in ivory command, according to their talent, much higher wages.

Working Hatmakers' Association.

The exhibit of the Working Hatmakers' Association is interesting as the result of a combination of 220 workmen, each of whom has, at least, a share of 100f. in the general undertaking. The association has a capital of 40,000f. As a rule, the society employs only from twenty to twenty-two of its members at a time. The rest labour in other workshops, but all participate, each according to the amount of

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his shareholding, in the profits of the society. The introduction of machinery into hatmaking caused great commotion in 1855, but it has now been long accepted as a *fait accompli*, and the workmen no longer complain that they suffer by it. A Paris working hatmaker earns generally about 4*s.* a day.

Diamond cutting and polishing.

M. Bernard's diamond cutters and polishers are Dutchmen, whom he has brought to Paris to endeavour to establish a Parisian diamond-cutting trade. But this trade requires an apprenticeship of twelve or thirteen years, and in Holland, at least is poorly paid. M. Bernard, I believe, is helped in his endeavour by a subsidy from the French Government.

Conclusion.

In conclusion, although the results sought by the Imperial Commissioners in planning the tenth group have not been realized, at least in Classes 94 and 95, these classes express a generous and a lofty intention. They constitute a recognition of the workman's right to some share in the honours of a universal exhibition of industry. I think a more immediate and practical good, however, might have been attained by the arrangement of a complete exhibition of cheapness, on the plan of that hastily got together by Prince Napoleon in 1855, and also by a comprehensive and complete exhibition of the industry of female hands.

List of works on French industry.

I append a list of works on French industry, and especially on Paris industry, that may be useful to those who are seeking a thorough knowledge of work and wages in France:—

The two inquiries into the state and customs of the industries of Paris instituted by the Paris Chamber of Commerce.

The annual general reports of the Assistance Publique, edited by the chief administrator, M. Armand Husson.

"Annales du Travail." Rue Notre Dame des Victoires, 11.

"Notice sur l'Universelle, Société dans le but de propager les Associations co-opératives et toutes les Institutions utiles en général." Guillaumin et Cie., Rue Richelieu.

"Statistique de l'Industrie de la France." Par A. Moreau de Jonnès. Guillaumin et Cie., Rue Richelieu, 17.

"L'Enquête du Dixième Groupe, Catalogue Analytique." Dentu, Libraire.

"Les Populations Ouvrières." Par A. Audiganne. Capelle, Rue Soufflet, 16.

"L'Annuaire de la Charité." Par E. Knoepflin. Dentu.

"Les Ouvriers de Paris." Par Pierre Vinçard. Gosselin, Libraire.

" Rapports des Délégués des Ouvriers Parisiens à l'Exposition de Londres en 1862. Chabaud, Rue Dauphine, 34.

" L'Ouvrière." Par Jules Simon.

" Les Institutions Ouvrières de Mulhouse et des Environs." Par Eugène Véron.

" Le Travail." Par Jules Simon.

" Statistique de la France." Par Maurice Block.

" Consommations de Paris." Par Armand Husson. Guillaumin, Rue Richelieu, 14.

" The Children of Lutetia; or, Travels among the Working Poor of Paris." By Blanchard Jerrold.

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# INTRODUCTION.

THE following Reports on the various Classes in the Paris Exhibition, 1867, were prepared for the Science and Art Department in accordance with the directions of the Lords of the Committee of Council on Education, and must not be confounded with the International Jury Reports to be issued by the French Government, which are quite distinct.

The scope and object of these Reports will be gathered from the following extracts from the letter to the gentlemen who were requested to prepare them, and who in many cases were not connected with the International Jury:—

"The Lord President of the Council, following the precedent of the Paris Exhibition of 1855, is desirous of obtaining a series of Reports on the objects exhibited in the Paris Exhibition of this year. . . ."

"The special object of this Report is to direct the attention of British visitors, manufacturers, and others, to the useful novelties exhibited by various nations on the present occasion, to which it appears desirable their attention should be called. It is not intended to be an exhaustive Report upon the Class, which it is presumed will be made by the International Juries for the Imperial Commission. The British Report should have special reference to the objects exhibited by the British Colonies and by Foreign Countries, rather than those exhibited by the United Kingdom, although the latter should not be overlooked."

"It is desirable that the Report should be as short as may be consistent with the nature of the subject, and it is absolutely necessary that it should be published during the Exhibition. It will therefore be indispensable that if the Report be undertaken by you, the manuscript should be delivered before the 15th of June at latest, and as much earlier as may be possible, to Captain Donnelly, R.E., the Secretary to the British Juries, who will afford all neces-

sary information in Paris, and will act as Editor to the Reports."

"It is probable that the Exhibition will be sufficiently arranged to enable an examination of the Class to be commenced about the 15th April."

With the view of rendering these Reports useful to the public while the Exhibition lasted it was determined to publish them in a newspaper as quickly as possible. Arrangements having been made with the manager of the *Illustrated London News*, who undertook to produce them free of all cost to the Science and Art Department with a certain amount of illustration, the publication commenced on the 6th July 1867, and continued till the 7th December. By that time about two-thirds of the Reports had been published. These have been revised by the authors, and with the unpublished ones are complete in these volumes.

In arranging the Reports the order of the French classification has not been implicitly followed. The amount of matter rendering the division into four volumes desirable, those Reports were brought together in each volume which appeared most allied to one another, an arrangement dictated as much by what seemed likely to be to the convenience of purchasers of single volumes as by any idea of a scientific classification.

# REPORTS.

## Apparatus and Processes for Ventilating, Warming, Cooking, and Lighting. — (Class 24.) — By Captain Webber, R.E.



These subjects, intimately connected with our daily life, have been so frequently treated of by writers of all countries, and have received so much attention of late years, that most people of any education have made them matters of consideration. But, too frequently, in the cases of warming and ventilating, the first receives more attention than the last, and, but for the nature of the construction in our houses and buildings, the air we breathe would be soon seriously unwholesome.

A little thought will show that these subjects taken together or separately, must be dealt with differently, according as they are applied, to small and large dwellings, or to public rooms where large numbers of persons meet. And further, it is not difficult to understand that the changing circumstances of climate and other natural causes will affect seriously any arrangement which may be made in a building to secure a proper renewal of the air at a comfortable temperature, necessitating on the part of the architect a knowledge of the true principles and laws by which he must be guided, and presenting in each instance new difficulties and subjects for investigation.

That civilization is urgently demanding from science an efficient system or plan for the ventilation and warming of dwellings there can be no doubt; and therefore an inquiry into those principles and the overcoming of these difficulties is the object of many men both in England and the continent of Europe, resulting at the Paris Exhibition in several well-considered plans for the warming and ventilating of public buildings, together with subordinate apparatus and appliances, all more or less efficient for the purpose.

Many of these are the works of skilled architects and engineers, who, as such, have applied their knowledge of a few natural laws to the task of rendering more wholesome and habitable the buildings they were erecting.

Some apparatus are the result of the requirements of private individuals, who, like Dr. Arnott, have felt a personal

Capt. Webber on Ventilating, &c.

want and have seen the same necessity for others. But they have all originated under different circumstances; each has in its own situation proved useful; and from them practical common-sense lessons applicable to the economy of our daily life can be drawn.

In a case where legislation cannot compel, philanthropy can only lead the way, and personal interest be the motive power. The educated classes are gradually becoming convinced of the advantage to health and pocket arising out of proper attention to nature's requirements; and to meet this demand in the large assembly rooms and theatres of Paris, M. Hamelincourt and the Maison Léon Duvoir Le Blanc have planned systems of warming and ventilating, of which they exhibit ample illustrations.

## Ventilating Apparatus.

General Morin's principles.

In a paper read by General Morin at a meeting of the Society of Mechanical Engineers, held in July 1867 at the Conservatoire des Arts et Métiers, the following principles for the ventilation of buildings are laid down, and as a knowledge of them cannot be too widely spread, their repetition here will not be superfluous:—

"Ventilation consists in getting rid of all vitiated air and replacing it by fresh air.

"The principal object is to get rid of it at once; it ought, therefore, to be removed from the point nearest to where the vitiation has taken place, and *vice versâ*, fresh air should be introduced at the point furthest removed from the occupants of the room.

"The removal of the vitiated air by suction is more perfect in its results than by blowing it out.

"A judicious arrangement of pipes and inlets will ensure the removal of the air by suction without the assistance of a blowing apparatus.

"Ventilation by suction can be obtained by the aid of the ordinary open fireplaces, stoves, or by exhausting flues. Where possible the air should proceed direct from the source of vitiation by special flues towards the bottom of these fireplaces.

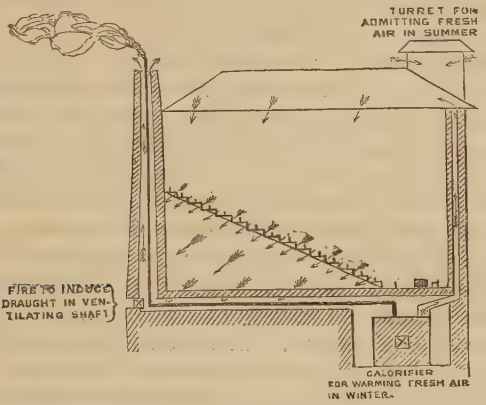
"Ventilation by suction is also superior to ventilation by blowing apparatus on account of its simplicity and its easy adaptation to the usual warming appliances.

"Its superiority in hospitals also consists in there being no danger of a diffusion of the vitiated air of one room to another, when it happens that the opening of doors and windows disturbs the movements of the air.

"In the rare cases where special blowing apparatus are really necessary, as where the quantity of fresh air to be

supplied is continually varying, they should be always employed in connexion with suction produced in the manner described."

The Maison Léon Duvoir Le Blanc illustrates by a drawing (of which a sketch is attached) the system of ventilation carried out on the principles advocated by General Morin, and applied to a lecture amphitheatre at the Conservatoire des Arts et Métiers at Paris.


TURRET FOR ADMITTING FRESH AIR IN SUMMER
FIRE TO INDUCE DRAUGHT IN VENTILATING SHAFT
CALORIFIER FOR WARMING FRESH AIR IN WINTER.

MODE OF VENTILATING AND WARMING THE LECTURE THEATRE OF THE CONSERVATOIRE DES ARTS ET MÉTIERS.

Ventilation of lecture theatre.

In the illustration the plan followed can be easily understood; the air to be supplied is collected in the space between ceiling and roof. In summer it enters this space by openings communicating with the external air; in winter the space is filled by air which has previously been warmed by an apparatus under the building, and from which it is led by an ordinary flue. The air is allowed to descend from this space into the amphitheatre by numerous openings in the ceiling, and it is induced to do so by being drawn off through similar orifices made in the risers of the steps under each row of benches, the suction being produced by a fire lighted at the foot of a shaft which communicates with the space into which the vitiated air has been drawn. The smoke pipe of the calorifier is shown by a thick line in the axis of the ventilating shaft.

The objection which would strike most people is that the entry of the fresh air above the heads of an assembly and its exit between their legs could hardly be effected without personal inconvenience.

The intention is to supply 1,000 cubic feet of air per hour for each person. The velocity of the current of vitiated air should not exceed 2·6 ft. per second at the openings, 3·9 ft. per second in the shaft, and 6·6 ft. per second at the outlet.

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The velocity of the current of fresh air should not exceed at the inlets 1·6 ft. per second. The air in the theatre in winter should be about 68 deg. Fahr., and it should therefore enter the room at a temperature of about 64 deg.

There is a separate heating apparatus for the room, to be used for warming it when not occupied.

Ventilation of Grand Opera, Paris.

M. Hamelincourt, Rue Salneuve, 29, Paris (who has been awarded a gold medal), in his design for the ventilation of the Grand Opera, provides for separate systems of ventilation in the summer and winter; in the one case admitting the external air direct, in the other heated. In both cases the fresh air is procured from an opening at a considerable elevation to insure greater purity, and enters the house between each tier of boxes. The foul air is drawn downwards through openings in the floor of the house, thence through flues which pass outwards to the walls, then ascend and converge to a common central shaft over the dome of the house, which has an outlet for the vitiated air under the cupola. The draught in this great central shaft is promoted by the ascent of the heated air nearest the ceiling of the house, which has access to it through perforations. Thus it will be seen that the air is renewed by entering in a horizontal direction at the sides of the house and going out at the top and bottom, the movement of the air in the pipes, by which it is drawn down through the floor, being created by artificial heating. The success of such a system will depend on the complete but imperceptible changing of the air to meet fully the requirements of the largest audience; but it is imperative that the air drawn out at the floor should not contain the products of the combustion of the gas used in lighting the house.

## Ventilation of the Exhibition Building.

Ventilation by compressed air.

Although not strictly coming within the range of group 3, to which class 24 belongs, the system of ventilation adopted in the building itself in the Champ de Mars must not be left unnoticed, as representing in the newest way the system by compressed air proposed by Messieurs Piaron de Mondesir, Lehaitre, and Jullienne. A very full description of this system was communicated by the former gentleman to the Society of Civil Engineers of France in the months of February and March 1867, and the whole apparatus is to be seen daily at work in the Exhibition building.

In comparing his system by compressed air with those which he describes as by mechanical force and by the direct draught produced by heat, M. Mondesir claims a superiority in the amount of air moved for every pound weight of combustible employed.

Supposing the air to be moving at equal velocities; from experiments, (extracted from the work of General Morin on ventilation,) with a mechanical ventilator, which may be said to drive the whole mass of air set in motion, he states that the value for every kilogramme of coal expended is 1,200 cubic metres; by the draught produced by the direct action of the heat on the air, for every kilogramme of coal, 2,700 cubic metres; and by experiment with his system of using compressed air to induce a current, for every kilogramme of coal, 5,588 cubic metres. In comparing the two latter systems a further advantage is claimed for the last, as the rate increases at which the air is required to move, which is; that in the first the consumption of combustible increases with the cube of the velocity, whereas in the last it increases only in proportion to its square.

The system of ventilation by compressed air may be simply described, as consisting in the introduction of a jet of air at a pressure from a tube into a ventilating shaft of any size, the jet being turned in the direction in which it is desired to induce a current; and, theoretically, within certain limits, the quantity of compressed air leaving the jet, multiplied by its velocity, is equal to the quantity of air passing out of the ventilating shaft, multiplied by its velocity. Any of these conditions being given, the size of the tubes and value of the motive power can be easily calculated by means of the equations given in Mons. Mondesir's paper; formulæ prepared by him from practical experiment, and to which he has applied all necessary corrections for friction, temperature, &c.

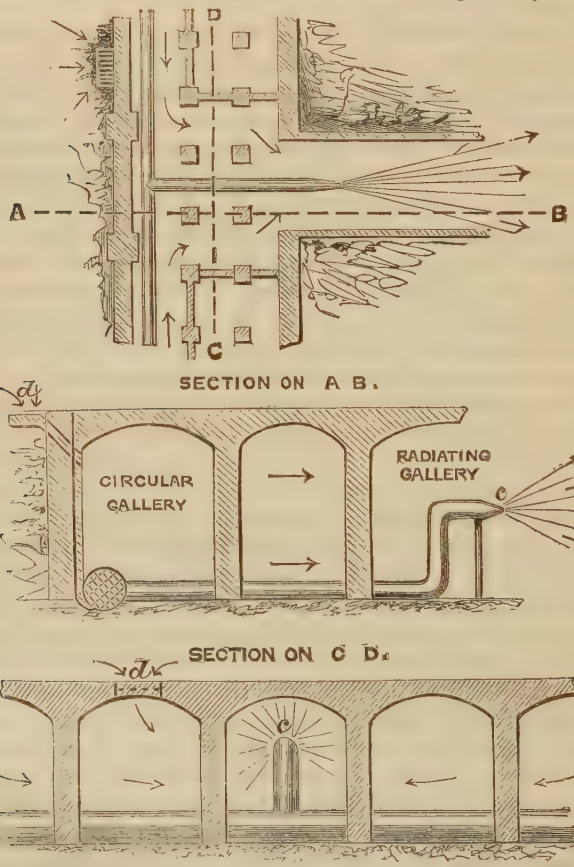
Its application to Exhibition building.

The application of the system to the palace in the Champ de Mars was determined on after experiments carried out by Mons. Krantz, chief engineer of Ponts et Chaussées, and Mons. Tresca, of the Conservatoire des Arts et Métiers. It may be thus described:—The subterranean air shafts, which have a mean width of 10 ft. and height of 6 ft. 6 in. correspond in number with the circular and radiating passages in the building, and in the case of the circular ones exactly in position (*see* wood-cut). The external circular gallery, which is situated under the outside verandah of the building, is fed with air from openings in the park at a distance of 60 or 70 feet, at 16 places, nearly equidistant. From this, 16 radiating galleries pass under the building to a distance of nearly 400 feet, reaching close up to the wall of the picture gallery; these communicate with others which coincide with the circular passages, and in which are situated all the gratings for the admission of air. The galleries in each of the 16 *sections* are isolated, so that each radiating gallery only communicates with the circular ones on its right-hand side, its left-hand wall being continuous. The pipe for the

CAPT. WEBBER ON VENTILATING, &C.

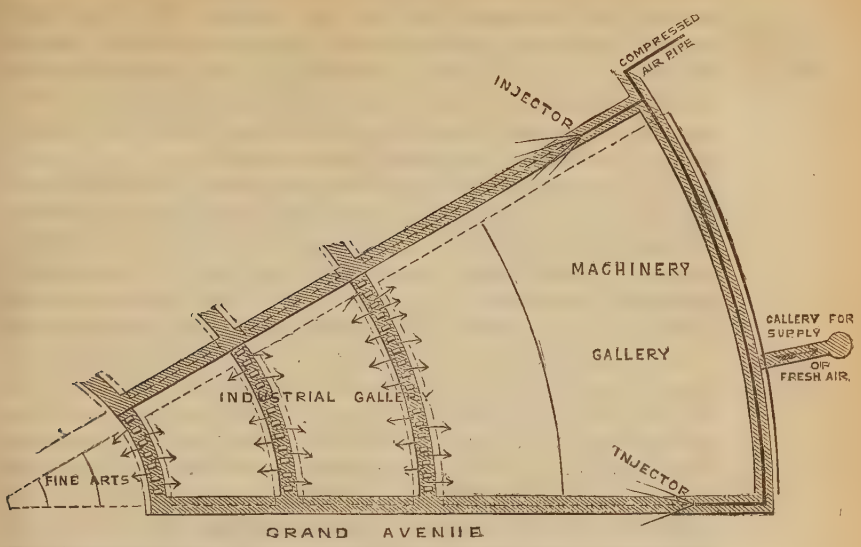
compressed air circulates in the outer gallery communicating with the pumping engines in the park. At each radiating gallery a tube of smaller dimension leaves it and enters for a few feet, then, bending upwards, discharges the air along the gallery in a line coincident with its axis. By means of this jet the column of air in the galleries is set in motion, making its exit through the gratings at a rate which can be governed by the velocity at which the compressed air leaves the tube, the sectional areas of the openings in the gratings taken together being equal to the sectional area of the radiating gallery. To compensate for a deficiency in the supply of fresh air, openings with gratings have been made in the circular gallery itself.

Plan and Sections of a portion of the Ventilating Gallery.




SYSTEM OF VENTILATION IN THE EXHIBITION BUILDING.

*d.* Additional openings for the admission of fresh air to the circular gallery.
*c.* Injector.




The air passages are represented by the shaded portions, with the gratings for the admission of fresh air to the building, marked on the circular ones.

SYSTEM OF VENTILATION IN THE PARIS EXHIBITION BUILDING.

Example showing one section of Palace.

It had been ascertained by previous experiment, that for every horse power of motive force developed 13,970 cubic metres of air was moved in one hour, at the rate of one metre per second of time. It was required that the air should enter the palace at the rate of two metres per second, which would give a quantity equal to 6,985 cubic metres for every unit of horse power, or 6,700, allowing for friction. Supposing that 4,375 persons were at one time in one *section* of the palace, and that each required a supply of 10 metres of air per hour, they would require 43,750 cubic metres altogether, to obtain which $6\frac{1}{2}$ units of horse power must be expended. To supply this in the same proportion throughout, four engines, amounting together to 105-horse power, were established in convenient situations. The conditions are approximately the following:— The sectional area of the gallery is 6 metres, through which the air moves at the rate of 2 metres a second. The amount of air passing out of the orifice of the injector is ·5 metres per second, the size of which is adjusted so as to give the required velocity which, theoretically, should amount to 24 metres a second, but, practically, must not be under 27 metres. The cost of thus ventilating the palace of the Champ de Mars is calculated at about one penny the 1,000 cubic metres. The galleries all having louvre openings in the roof, the circulation of the air is good, except where the courts have been much shut in. The proximity of the kitchens

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under the restaurants to the air passages has frequently caused a smell of cooking to be experienced in the building in cases where, for better ventilation, the proprietors have broken openings between them. The Imperial Commission, where they found this evil incurable, suspended the ventilation of the *sections* in which it was situated.

This system also allows of the introduction of cooled air to the space to be ventilated, by making use of the fact, that air in expanding from a state of pressure decreases in temperature. The air having gained in temperature by being under pressure, loses some by its detention in the tubes, and consequently, on expansion, falls to below the original temperature.

Its application to other buildings.

It is proposed by the inventor to insure the steady and regular supply of fresh, and exit of vitiated air, in hospitals, by the introduction of a jet into both supply and escape flues, only using heat to warm the air in winter to the necessary temperature. The motive power to ventilate an hospital of 600 beds, allowing 100 cubic metres per hour per bed, is calculated to be fourteen horses. Enough has been said, without going beyond the bounds of this report, to explain the principles of the system.

In the paper before referred to, M. de Mondesir describes his mode of applying it to public buildings, ships, and mines. Those already possessing the spare motive power may well consider the application of it to the ventilation of factories, workshops, and places where workmen are engaged in unhealthy or dangerous occupations.

A working model explaining the system is exhibited in the Machinery Gallery, close to the stationary engine in the section belonging to South Germany.

Before quitting this subject, the writer would suggest that it might be worth while considering it with reference to the systems of ventilation already adapted to large public buildings in England; for instance, the Houses of Parliament or Guy's Hospital.

A moment's thought suggests that in the former, supposing what the French engineers advance to be right, the ascent of the fresh air through a perforated floor must be wrong. Perhaps it *is* true what hon. members say, that "one feels as "if in a cold bath." May not this sensation be produced by the slight pressure of the air caused by its passage through a perforated medium on entering the House? Might it not be conceived that actually, members are sitting close above innumerable small jets of air, the force of which does not cease before reaching their legs? The quality or temperature of the air would not prevent the sensation of cold. And, can it not readily be believed that, supposing the whole mass of air in the House to be descending instead of ascending, and

the velocity, in consequence, somewhat delayed at the floor before passing into the space below, the sensation of draught would cease to exist?

If ventilation by heated air-shafts or mechanical ventilators has not hitherto been completely under control, as at Guy's Hospital and the Houses of Parliament, has not M. Paul de Mondesir, by his system of compressed air, placed within reach, for adaptation to both those buildings, even at this late period, a means which economically gives the power of regulating the volume and velocity of the air, as well as almost a complete control over the direction in which it moves? Although not the originator, M. Mondesir has practically carried out this idea, not dissimilar to that suggested several years ago by Dr. Thomas Young, who then proposed the employment of a jet of steam.

Apparatus for ventilating and lighting.

The only apparatus for combining ventilating with lighting apparatus are those of Messrs. Benham and Son, the well known manufacturers of Wigmore Street, and of Messrs. Strode and Co., St. Martin's-le-Grand. These are respectively known under the names of "Ricket's ventilating globe light," and "sun light." The former contains three ducts, communicating with the external atmosphere; the first for the escape of the products of combustion of the gas, the second for the exit of vitiated air from the room, the third for the entrance of fresh air. The latter carries off the vitiated air, together with the products of combustion, by one shaft, which contains a valve, to be closed when the lamp is not in use. It is best adapted for large public rooms; and Messrs. Strode have added a small battery, so that the lamp, when situated at a great height, can be lighted by an electric spark. The induction of the current by a revolving magnet to be turned by the hand would be more practical for ordinary use than the wet battery, as the latter is more liable to get out of order in the hands of ignorant persons.

Both these manufacturers fixed their "lights" in the largest room of the English testing house, where they were daily lighted for the inspection of visitors. Unfortunately time did not admit of their being practically tested as to their ventilating powers, and therefore nothing can be safely stated as to the work performed by them.

Ricket's light by Benham is essentially adapted for a dwelling room. The tube for the escape of the products of combustion of the gas is doubtless sufficient for its purpose; and if the current in the tube for extracting the air of the room can be induced to move at the rate of 3 feet per second it would give a total result of 1,500 cubic feet per hour, or 150 cubic feet for each of 10 persons collected in a room. Considering that in most dining rooms the products of gas

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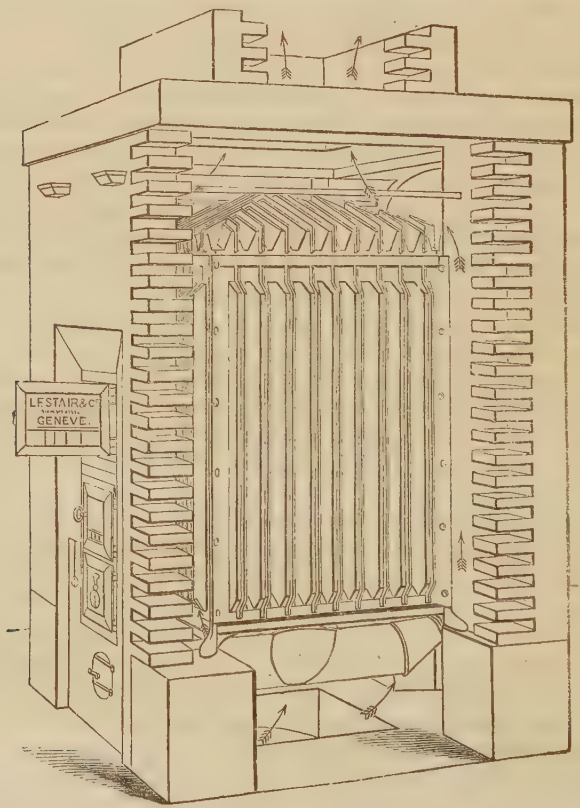
mix with the air we breathe, and that there is no direct means of drawing away the heated air at the ceiling, this is a great advance in the right direction, but its use is limited to the wealthier classes. Mr. Benham's claim in favour of the heating the gas previous to consumption, is treated of in the report on results of testing gas burners.

## Warming Apparatus.

Messrs. Weibel's calorifier.

Amongst the apparatus especially designed for warming air, is that of L. F. Staib and Co., of Geneva, exhibited by their successors, J. Weibel and Co., of the same place, to which has been awarded a gold medal.



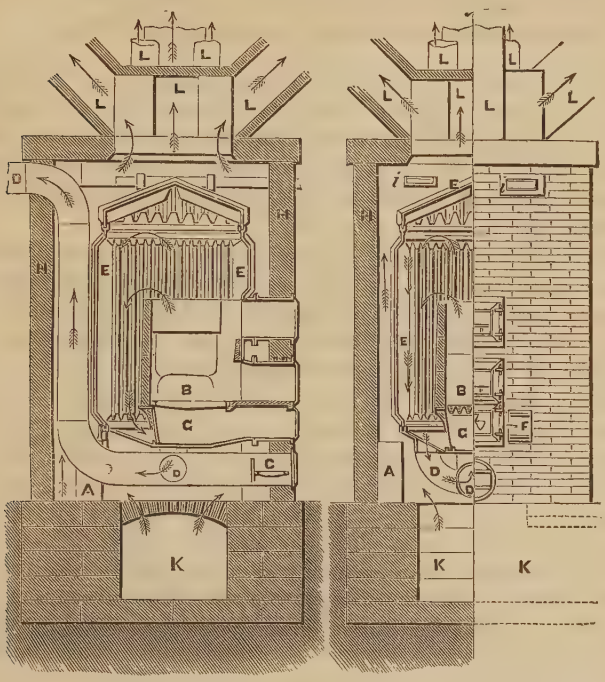

HEATING APPARATUS OF MESSRS. WEIBEL AND CO., GENEVA.

This apparatus has been exhibited previously in 1856 at Paris, and in 1862 in London, where its manufacturers were also rewarded with medals.

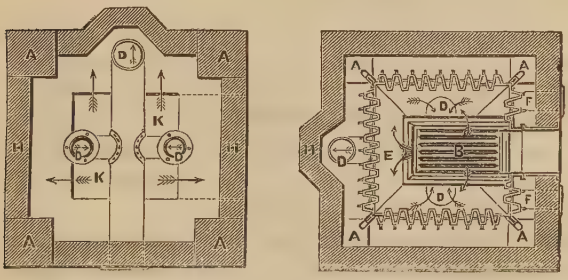
It is claimed for it, that the air heated by it is not deteriorated, great simplicity of construction, large heating

surface for the size, and the advantage of adding moisture to the air. They recommend its use especially in large buildings, such as manufactories, schools, and assembly rooms.






Longitudinal Section. Transverse Section and Elevation.




Air Passage and Chimney. Horizontal Section.

HEATING APPARATUS OF MESSRS. J. WEIBEL AND CO., GENEVA.

A. Masonry supports of the apparatus.
B. Fireplace.
C. Small grate for producing a draught when lighting, which can be taken out to clean the chimney.
D. Smoke-flue.

E. Corrugated wrought-iron walls, forming the four sides of the apparatus, bolted at the angles and having a groove to receive the cover.
F. Soot-doors.
G. Ash-draw.
H. Outer casing of brickwork, completely detached from the apparatus.
*i*. Pans containing water to moisten the air by evaporation.
K. Entrance for fresh air, cold.
L. Passages to conduct the warm air to the rooms of the building.

This apparatus is especially recommended by M. Warthmann, professor of physics at Geneva, who informs me that since the year 1852 the Great Hospital at Geneva has been heated with it. He states that it was approved by the Swiss Government for that purpose, after having been reported on favourably by him.

M. Warthmann's opinion of it.

The professor (to quote his own words) having completed his own country house in 1862, subjected this apparatus to the most careful tests. The one in question was required to heat the whole house, including the usual sitting-room and staircase, six bed-rooms, and a large library.

During November and December, 1862, the house was neither inhabited nor warmed. In the coldest days of January, 1863, the apparatus was lighted, and after the second day a temperature of 56° Fahr. was obtained in the centre of each room at the level of one metre above the floor, the mean external temperature being 21° Fahr. Afterwards, thirty kilogrammes of coal per day, burning about twelve hours, made a difference of 36° Fahr. between the external and internal atmosphere in all the rooms, and this heat was maintained within 10° during the night. The house is well built of stone in a very exposed situation, but no special precautions against cold, such as double windows, have been provided.

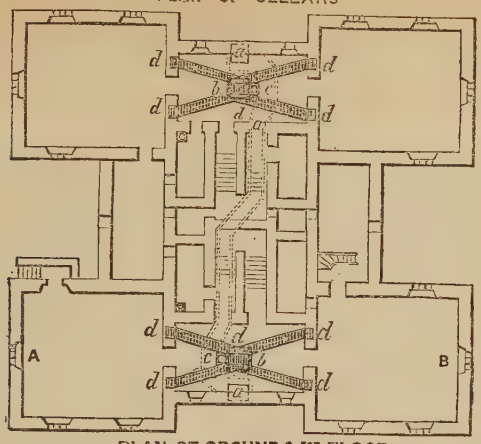
Not having had the means of testing the apparatus, the writer is glad to be able to publish the evidence of so reliable a witness, more especially as its appearance bore out all that was claimed in its favour.

Professor Warthmann concludes by claiming a twelve years' priority for Messrs. Weibel's apparatus over any similar one constructed in England.

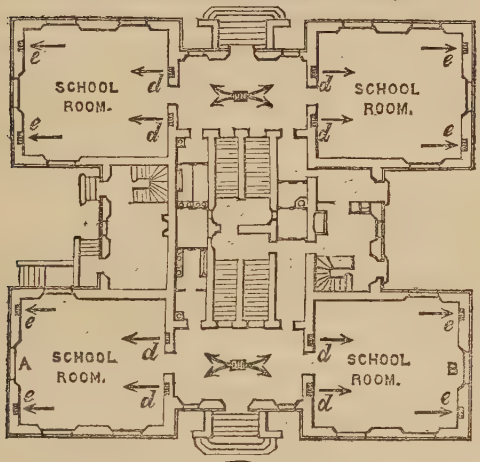
Messrs. Weibel construct heating apparatus, on the principle shown in the illustration, of all sizes, down to those adapted for single rooms.

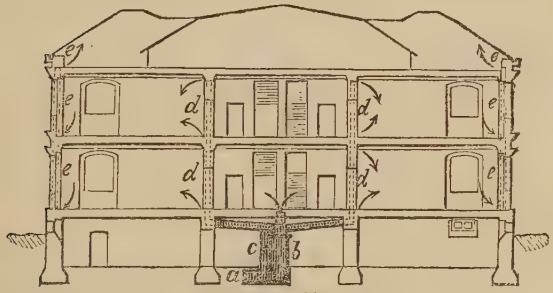
The illustration of the way in which one is applied to the warming and ventilating of a school for 1,000 children in Geneva, sufficiently explains its use for most purposes, and may make useful suggestions to those interested in the schools in populous towns of England.

PLAN OF CELLARS




PLAN OF GROUND & 1st FLOOR.




SECTION ON A.B.

MESSRS. WEIBEL'S APPARATUS APPLIED TO A SCHOOL HOUSE.

*a, a, a.* Passages carrying the fresh air to the apparatus.
*b, b.* Apparatus. *c, c.* Helicoidal ventilators, for summer ventilation.
*d, d, d.* Passages distributing the fresh air, warm or cold, to the rooms.
*e, e, e.* Passages for the escape of the vitiated air from the rooms, available in summer and winter.

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According to the "suction" theory, one improvement might be effected—viz., the utilization of a small quantity of heated air to induce a draught in the passages for the escape of the vitiated air.

Besides this, there is a large number of exhibitors of warming stoves, or "calorifiers." France, in the annexe close to the Porte de l'Université and in Gallery 3, shows a considerable number of calorifiers, all of which are more or less on the well-known principle of warming the air by passing it through a considerable length of iron pipe, inside a brick chamber where the air becomes heated by contact with the pipes, those exhibited by Baudon Fils, of Lille, and Coignet Frères, Paris, being the best. There are numerous examples of small stoves all more or less on Dr. Arnott's principle of which those by M. Jolley & Co., 4, Rue de Rougemont, Paris, Baudon Fils of Lille, and Boutier of Lyons are the best. Experiments have been carried on with some of these in the English testing-house, of which a full report is given.* The question of the general principles of their construction and use, is all that will be here referred to.

Exposure of air to heated iron.

Much prejudice exists on the exposure of air to a heated iron surface, and it is supposed that the quality of the air will be deteriorated by contact with iron which is either very hot or approaching redness. Chemically this is a fallacy; the change in the iron is so imperceptible that practically the air neither gives nor receives while in contact with it. As long as the proper amount of moisture is preserved, and the heating surface clean, no unwholesome effects will be produced. The disagreeable smell that is experienced in a room where an overheated stove is situated, most probably arises from the consumption of animal exhalations and similar matter, that are in suspension in the air.

The qualities of a good warming apparatus consist rather in its utilisation of the fuel it consumes, or, in other words, in the amount of air warmed for every unit of combustible; together with good construction, and the power of regulating the production of warmth with the smallest expenditure of labour.

Use of stoves.

In England stoves are generally used where the cheerful blaze of an open grate is not desired. In France, frequently they are moved into a room (or cupboard adjoining it), the smoke pipe put into a hole communicating with a flue, and

* *Vide* Testing House Report.

when the room is warmed carried back again. In Germany, Russia, and America, the stove is generally stationary in every room. The defect in this mode of warming, which consists in having the source of heat situated in the dwelling-room, is more or less felt according to the form of its construction. By degrees the benefit to be derived, both as to comfort and economy, is causing the adoption in all but the first-named country, of one or other description of heating apparatus which is the common source of warmth for *every* room in the dwelling, doing away with the use of small stoves, except in certain situations.

In England this change will only come about by slow degrees as regards dwellings. Until compelled for economical reasons people will continue to have grates in their rooms and stoves elsewhere. It will take more than a generation to do away with the cheerful blaze of the fire in every room and to prove to the multitude the waste of heat and accession of draughts caused by it.

There is no reason why one blazing hearth should not be retained in every house, or indeed an open grate in every room for use if required. But at the same time every dwelling, rich and poor, might be warmed throughout by a slow-combustion apparatus in the basement, which would utilise the whole of the fuel instead of allowing nine-tenths of it to escape.

Take, for example, one of the houses which are daily springing up in the suburbs of our large towns, containing (say) ten rooms, each room having an open grate with a flue. In winter every room that has not a fire constantly burning in the grate is either badly ventilated or uninhabitable from the cold. At the lowest calculation each grate consumes 25 lbs. of coal a day, which gives 250 lbs. for the house. Accompanying this consumption there is a considerable amount of labour in feeding the fires, difficulty of regulating ventilation and draughts, and a considerable nightly lowering of temperature. Give up the use of nine out of ten of these fires, use 50 lb. of the 225 lb. of coal thus saved to warm a calorifier in the basement, construct a system of warming and ventilating flues, and, besides the saving in fuel and labour, an absolute power of regulating the change of air at a proper temperature throughout the house is obtained.

Warming a house by water in Germany.

In Germany the writer has seen the following means of warming adopted in lately constructed houses. In each room is placed a water-tight cylindrical vessel about 8 ft. high and 2 ft. diameter, in the same spot where the porcelain stove once stood. Connecting these vessels with a boiler in the basement and a large water cistern on the roof is a system

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of pipes, which in the ordinary way cause the vessels to become filled with hot water instead of cold when the boiler is heated; the introduction of stop cocks at proper places enabling the occupants to regulate the temperature. In Gallery 3, Mons. P. Gronville, 86, Rue d'Enfer, Paris, exhibits a model showing his application of this system to a building, and the writer believes that it is being carried out by him in a new prison for 1,000 cells in Paris.

Captain Galton's open grates.

The greatest advance in grates since the Exhibition of 1862 is in that exhibited in the testing house by the Secretary of State for War. This grate, the design of Captain Douglas Galton, has been generally adopted in the barracks of the United Kindom; and the economy of heat effected by it has considerably diminished the annual consumption of coal for the use of soldiers. It is made in three sizes, to burn 320 lbs., 260 lbs., and 240 lbs. of coal per week, and the system is adapted also to a small cooking range for the use of non-commissioned officers and married soldiers, to burn 130 lbs. a week. It is spoken of by General Morin as *the most important step towards economy of heat in the open grate that has been made for many years.* And in 1864–65 careful experiments were made with it (at Paris) under his superintendence, a full report of which is given in the "Annales du Conservatoire Impériale des Arts et Métiers" for those years.

Description.

This grate, which projects considerably into the room, is isolated from the wall in which it is set, the space between forming a chamber. This chamber communicates with the external air and the room, by means of small passages, of which the size is accurately determined, those opening to the room being close to the ceiling. The external air entering the heated chamber ascends, enters the room, and being unable to ascend further, passes in a horizontal direction towards the coldest surface such as the glass of the windows, where it descends to the floor and escapes thence up the chimney, producing a circulation of air that has been raised in temperature above its external state. The grate itself is admirably planned, and constructed in all its subordinate details to carry out its object of warming and ventilating a room, with the least possible waste of combustible.

General Morin's experiment.

The experiment made by General Morin was in a room containing 3,190 cubic feet. The trial lasted $11\frac{3}{4}$ hours, no fuel was added after the sixth hour, fire was out at end of 11 hours, total consumption 19·84 lbs.

Within half an hour of lighting, the air in the ventilating flues was in full motion.

For the next $5\frac{1}{2}$ hours a mean of 14,561 cubic feet of air entered every hour.

After $10\frac{1}{4}$ hours from time of lighting 10,242 cubic feet entered per hour.

At close of experiment the air was still coming in at a rate of 5,312 cubic feet per hour, at a temperature of nearly 64° Fahr.

During the first period the air was ascending the chimney at the rate of 18143·75 cubic feet per hour, showing that 20 per cent. of the air still entered by the ordinary way.

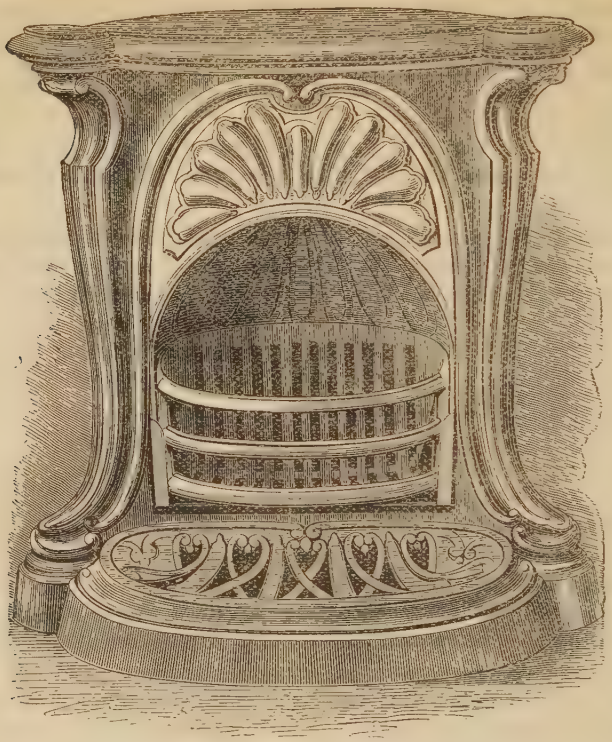
| | | |
|---|---|---|
| The temperature of the external air was - | 57° Fahr. | showing an increase of 27·7° Fahr. |
| It entered the room at - | 84·7° „ | |
| The temperature of room was - - - | 68° „ | showing an increase of 83° Fahr. |
| It ascended the chimney at - - - | 151° „ | |

From these results a calculation is made, that of the heat developed by the combustion of the fuel, 66 per cent was *lost*, 18 per cent entered at ventilator, and 16 per cent was communicated to the room and walls in the ordinary way.

In comparison with this General Morin mentions the result of an experiment with an ordinary grate under the most advantageous circumstances, which shows a *loss* of 84 per cent. of the heat.

The principal advantages of this grate are. No draughts of cold air are felt in the room, and, if desired, all joints and crevices in doors and windows can be closed, maintaining at the same time a perfect ventilation. A uniform temperature in all parts of the room, instead of the heat (as with ordinary grate) accumulating at the top. No interference with the draught of a chimney by fires being lighted in contiguous rooms. A large number of persons can be collected with safety in the same room. From the accumulation of heat in the walls of the hot air chamber, and in the fire-brick lining of the grate the entrance of warm air into a room will continue for many hours after the last replenishment of a fire.

M. Godin Lemaire, of Guise, France, has a very large exhibition of grates and stoves. The grates, like most in France, are all on the vertical bar form, which is adapted to the economical consumption of brittle coal, and at the same time allows of a large portion of the lighted surface of the coal to be exposed to the atmosphere.



STOVE-GRATE, BY GODIN LEMAIRE, OF GUISE.

One grate of this form (of which I was unable to obtain a *working* drawing from the exhibitor) is peculiar. It is of the same shape as the rest (*vide* cut), except that the whole of the coal basket can be turned on its vertical axis, so that the opening of the grate can be closed by the back when the basket is turned quite round. The object is, to let the coals burn up for a few minutes in one position, for which purpose the lower part of the back is formed of vertical bars (*vide* cut), for the admission of air; when the fire is well lighted the basket is turned round into its ordinary position, in which the opening for the escape of smoke is very small. This plan is adapted to the ordinary French grate in an enamelled iron mantle-piece, the whole costing about 70f. (*vide* cut).

Messrs. Engel and Tremblai, Rue de la Roquette, Paris, exhibit a very serviceable-looking porcelain mantle-piece, which is constructed so as to admit of a circulation of air behind the grate; the earthenware itself would retain the heat, and its appearance is very neat and clean.

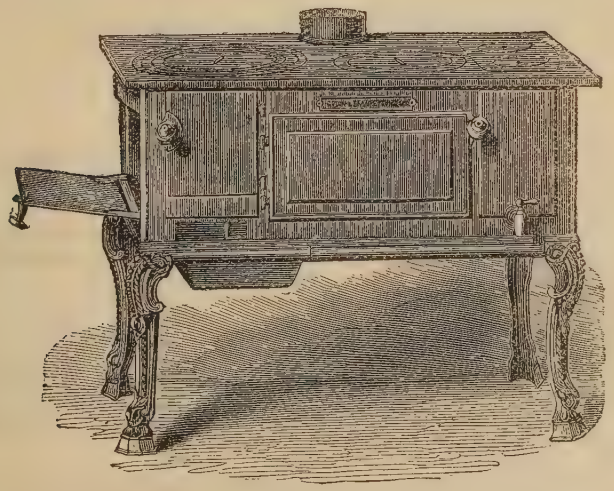
The Cie. Parisienne d'Eclairage et de Chauffage par le Gaz, exhibits, amongst other objects, a grate complete with a wire-gauze drawer, value 30f., which might be easily adapted to M. Engel's mantle-piece. The two together would be very well suited to small houses, the former as an economiser of fuel, the latter of heat.

The Compagnie des Appareils de Chauffage Mousseron, 17, Rue St. Gilles, Paris, exhibits an iron grate, which in its form for burning wood might be economically used in English country houses. The air of the chamber has free circulation round the back of the grate, by a front of ornamental trellis work of cast iron. Unfortunately the largest size manufactured is too small for English ideas. That to suit an opening of 2 ft. 3 in. square costing 3*l.* is *stated* to heat a room containing 10,500 cubic feet.

## Cooking Apparatus.

Small cooking stoves.

Of cooking apparatus adapted to small dwellings, illustrations are given. They are by M.M. E. Boucher and Co., Mousseron and Co., Baudon and Son, Boutier and Co., and Godin-Lemaire, of France; Messrs. Brown and Green, of Luton, England; and M. Akerlind, of Stockholm. Mr. Sparkes Hall, of Regent Street, also exhibits a cottager's grate; and there is the range for married soldiers already mentioned, which is made by Benham and Son, Wigmore Street, London.



COOKING APPARATUS OF GODIN-LEMAIRE, GUISE, PARIS.

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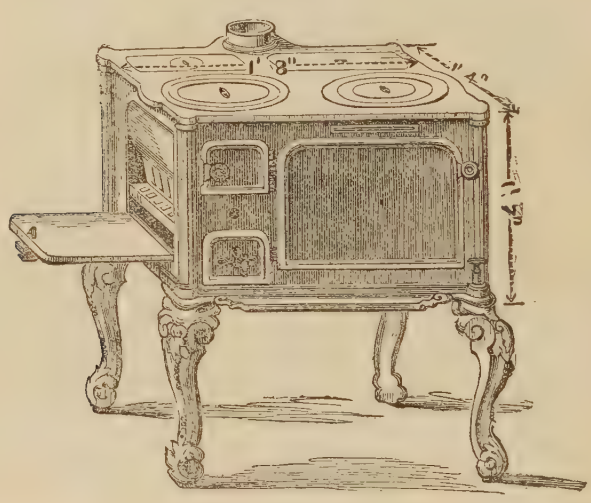
The principal objection to the French stoves is, that if the water in the boiler is required to be quickly heated, the oven becomes useless from over-heating. This is a serious defect, partially remedied by the introduction of fire brick into that of Messrs. Brown and Green, who, however, carry the smoke directly up the flue after passing over the oven, of which they only heat two sides.



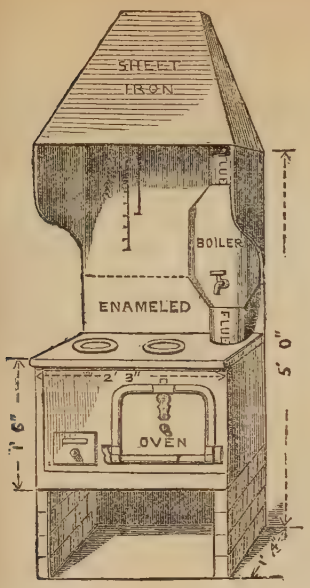
COTTAGER'S COOKING-STOVE, BY C. BOUCHER AND CO., AT FAMAY, ARDENNES.

M. Boucher's is remarkable for convenience and the completeness of the arrangements.

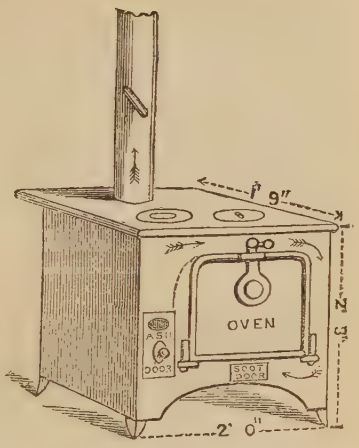
That of M. Godin-Lemaire is an example of a stove affording similar space, but with the boiler at the end instead of the back.

Mousseron's, as set in the Mulhouse workman's dwelling, appears very serviceable, has a large oven for its size, and helps to ventilate the room, but the water does not heat very quickly in the boiler on the smoke pipe, nor to a temperature above 150° Fahr.

Baudon's is very well constructed, and shows the high finish of all his work. It has a large oven and no boiler.



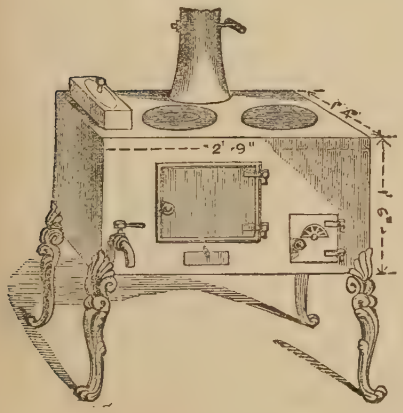

MULHOUSE WORKMAN'S COOKING-STOVE—Cie. Mousseron, *Maker.*



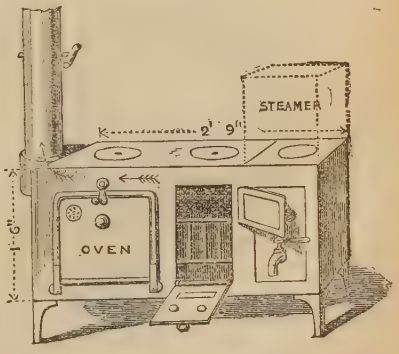

COOKING-STOVE FOR CITÉS OUVRIÈRES, BY BAUDON, OF LILLE.

Boutier represents the most ordinary form, and but for the fault of overheating, his oven would be very serviceable.

Brown and Green's is much more strongly made than the French stoves of this form; the oven has a ventilator, and




SMALL COOKING APPARATUS, BY BOUTIER AND CO., OF LYONS.




COTTAGER'S COOKING-STOVE, BY BROWN AND GREEN, OF LUTON.

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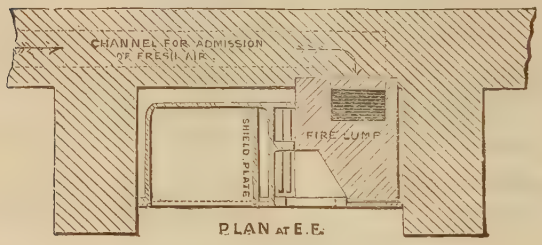
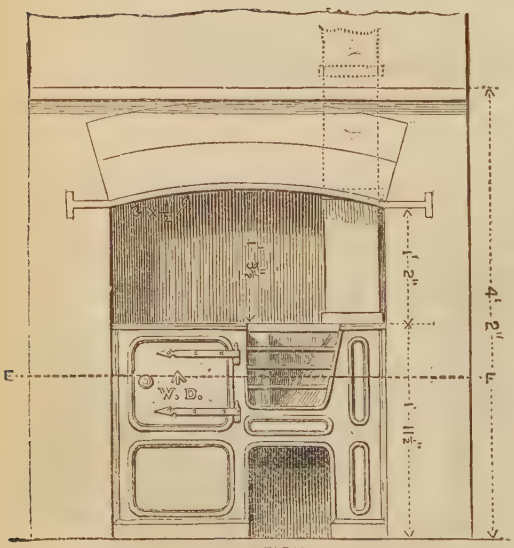
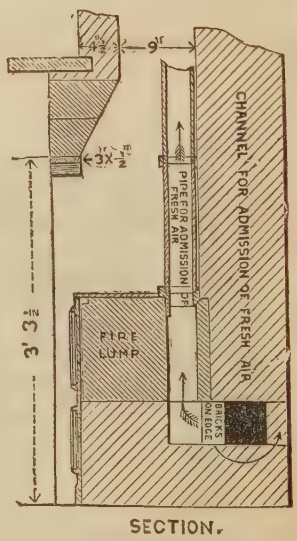
over the boiler a steamer can be placed; they also have a small roasting screen which can be attached to the bars when the doors are opened.

The cooking range for married soldiers exhibited by the Secretary of State for War is a form which would probably find greatest favour in small dwellings in England on account of the open fire. It costs 40*s.* at the Government contract price. With a very small fire box the oven is sufficiently heated for ordinary cooking purposes, there is room for a large pot on the fire, and another on the plate of the oven, and it possesses the advantage of having the ventilating arrangement of Captain Galton as shown in the plan and section below.

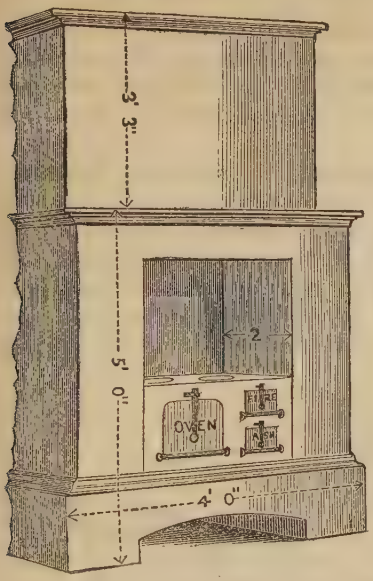



COOKING RANGE FOR MARRIED SOLDIERS, WITH VENTILATING ARRANGEMENT.

M. Akerlind's stove has nothing particular to recommend it for cooking purposes; but, as combined with a heating stove, it is very worthy of consideration for cold localities. The whole of the construction surrounding the cooking portion is faced with fire clay blocks covered with a white glaze, the interior is divided on each side into a descending and ascending flue, through which the smoke has to circulate before its exit to the main flue. In summer the opening of a damper allows the smoke to enter the flue directly without circulating in the stove. This apparatus is to be seen in the Swedish building in the park of the Exhibition, in the room arranged as a school. M. Akerlind also constructs ornamental stoves with open grates for dwelling rooms, at prices varying between 10*l.* and 20*l.*




AKERLAND'S COTTAGER'S WARMING AND COOKING STOVE (SWEDISH).

Those of Messrs. Boutier, Baudon, Barbezat (of which no illustration is given), Brown and Green, Sparkes Hall, and the married soldier's range, were tried, *vide* Testing House Report.

On the subject of cooking stoves for the poorer classes of the community much has to be done in the way of improvement. Fuel is daily becoming dearer, and the open grate will have to yield soon to the close stove or range in one form or other.

It is true that a good apparatus will not *make* a good cook; but there is considerable difference, on the point of economy and good distribution of heat, in different kinds of appliances.

What is required, and has been attained in France and Belgium, is a cooking stove that will keep alight all day and work to its full power perhaps for two hours of that time, with a consumption of not more than 8 lb. of coal, at a cost of $\frac{3}{4}d.$ to 1*d.* per diem. The addition of fire brick on each side of the grate, the placing the boiler between oven and fire and letting the flame pass over and *under* both, the

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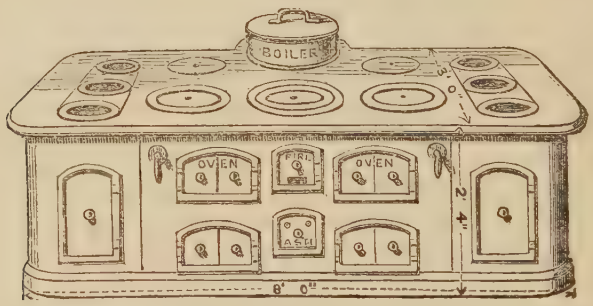
proper ventilation of the oven, the adoption of Messrs. Brown and Green's fire doors and steamer, of an extra boiler on the flue, and the ventilating hood of the Mulhouse stove, and perhaps an arrangement for further economising the heat in the flue, as in the Swedish, are all points for consideration, as they might easily be applied to the existing forms, and would certainly be improvements in the right direction.

Unfortunately there was nothing in this Class from the United States which would offer new suggestions, but the well known mode of heating water in a small cistern placed at one side, in the stove known in England as the "American stove" is worth notice. It is done by inserting a small boiler in the fire-clay back from which are carried two pipes to the cistern, but the water never reaches the boiling point.




LARGE COOKING-RANGE, BY M. VAILLANT, OF METZ.

Large cooking ranges.

Of large cooking ranges, France shows a great number, those of Messrs. Vaillant, of Metz (as seen in Illustration), being most noticeable. Of the merits of this form of range for cooking purposes the writer had no means of judging. As a general rule, when of such a size they are difficult to keep clean; and, unless alight day and night, take some time to warm up after lighting. The steam from the boilers is not utilized, and from their low flat form they take up a great deal of room.

This kind of French cooking apparatus, as is well known, is totally different to that used in England, for ordinary household purposes, being similar to those of which, on a smaller scale, several illustrations have been given. Little of the fire is seen, and the heat and smoke has to circulate through some extent of passages, around ovens, boilers, &c., before reaching the flue. These apparatus are as large and nearly as high as a good sized kitchen table, and a good deal

of work is done on the extensive surface of the hot plate. Notice should be taken of the way in which space is saved by having the coppers and pots fixed *in* the hot plate, so that about half their surface is affected by the heat. There is no doubt that with the use of these there is a great economy of fuel, the cook is not tried by much exposure to heat, and the access to three sides at least, is very convenient. Messrs. Baudon Fils, of 49, Faubourg St. Martin, have very fine specimens of these apparatus adapted for large houses, hotels, &c., which, with roasting jack, boilers, &c., cost 100*l.* Those adapted for ordinary establishments, occupying a ground space of about 5 ft. 6 in. by 2 ft. 9 in., with the same conveniences, cost 26*l.* These apparatus, entirely of iron, are supposed to be an improvement on those which have long existed of the same form, but made of brick. They are certainly more convenient, but it may be doubted if the entire abandonment of brick is good. Its combination with the iron, in the English cooking range, is a point in favour of the latter.

There is no reason to believe that the English form of cooking range, as exhibited by several makers, is less wasteful of heat than heretofore, except in the case of the range called "Richard's circular fronted," improved, made, and exhibited by Mr. W. Barton, of Boston, England. This is the only range that shows any originality of invention, and that in the right direction. The circular front enables the cook to stand at the hot plate without being exposed to the direct rays of the fire, and with room to work. The triangular shape of the fire box effects an economy of fuel, none of the heat being lost at the back. The boiler is of wrought iron, welded throughout, being worked at a slight pressure. The arrangements for utilising the steam from the boiler are very perfect, and quite under control, the steam being used to heat a coil from a reserve cistern on another story of the house, to cook with, and to warm a large hot closet for dishes and plates. The moveable bottom to the fire box, whether original or not, has been most efficiently adapted by Mr. Barton, and his arrangement for ash pit, dust flue, valves, &c. cannot be too highly spoken of. For a full description of the apparatus and the trials of it *vide* Testing House Report.

General remarks on cooking ranges.

In treating of the subject of cooking ranges for general use, readers should be reminded of the nature of the difficulties that are generally met with in families. The principal difficulty is the cook, but that should not prevent the adoption of the most serviceable and efficient form of range. Persons purchasing new ranges are too much at the mercy

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of ironmongers, who are, for the most part, ignorant of how to do away with local and inherent difficulties. There is no reason why all, who are interested, should not understand both the construction and the use of their kitchen ranges. The qualities to be demanded from a range are—economy of fuel, which means the least loss of heat after all the work required has been done; the proper communication of heat in due proportion, and in the least possible time, to all the different parts, without waste; and a control over the heat, so as to regulate the temperature in any one part; all this to be simply arranged so that anyone can work it. In addition, may be mentioned, facility of cleaning, repairing, and convenience, and personal comfort in using. Economy of heat will depend on the way in which the flame is made to circulate between the parts required to be heated with the least loss to the surrounding walls and plates, and also on the use that is made of the steam from the boiler. The proper communication of heat to the parts will depend on the form and nature of construction of the smoke passages, and on the efficiency of the valves and dampers placed to control its passage. It may be said that in few ranges are these conditions really fulfilled; but I have no hesitation in saying that in that of Mr. Barton, of Boston, they are more nearly fulfilled than in any other I have met. The setting of the range is one of the most important points in connexion with its establishment in a house, but this is a matter which will vary with its nature and the circumstances of the situation. As a general rule it is safer to engage the maker of the range to set it. Sometimes, with a good range, it is necessary to have a small door in the flue, to admit the lighted paper being introduced so as to induce a draught when lighting; and free access to the flue should always be obtainable.

The patent cooking apparatus invented by Captain Warren and manufactured by William Adams and Son, of Marshall-street Golden-square London, exhibited by the maker in the English testing house, and by Her Majesty's Secretary of State for War in the exhibition of barrack fittings, &c., is one of the most important objects of this nature in the Paris Exhibition. Together with Perkins's portable field oven, this object places within the reach of the British soldier the means of eating his food prepared in a way which far surpasses anything to be met with in any other army. By some unfortunate circumstance the jury (judging by their awards) failed to appreciate the peculiar excellence and originality of these apparatus. Had their labours extended over a longer period, so that they might have

witnessed the trials to which they were subjected, there can be no doubt that very different awards to those given would have been received by the inventors.

Perkins's military portable steam oven, which can be used for cooking purposes as well as baking in the field, is to be seen standing in the open air on ground adjoining the testing house. Descriptions and reports on the trial of these apparatus will be found in the "Testing House Report."

## LIGHTING APPARATUS: LAMPS.

The Exhibition shows a considerable number of lamps for burning mineral oils. But little progress has been made for the last five or six years, with the exception perhaps, of the lamps of Messrs. Vigan and Co., who have altered the general character of construction, and obtain results not worthy of much merit, except as regards safety. This applies to that form of lamp in which spirit of petroleum is absorbed by a spongy lining to the font, from which the volatile portion of the spirit is conducted by a wick to the burner, where it burns with a faint light.

In estimating the comparative value of the lamps the considerations are:—

1. Safety so far as the lamp itself is concerned.

2. Value of illuminating power in proportion to a given consumption of oil.

3. Qualities for assisting in producing perfect combustion, and consequent absence of smell.

4. Convenience of construction, both as regards facilities for cleaning and use.

5. Price, estimated with reference to good workmanship, as well as first cost.

6. Ornamental character of form.

Qualities which constitute a good lamp.

First. The safe use of a petroleum lamp depends chiefly on the quality of the oil employed; but with all oils certain forms of construction appear necessary, viz., the non-conduction of heat from the flame to the vessel containing the oil, best obtained by forming the latter of porcelain or (still better) glass; the free escape of volatilized portions of the oil, without chance of their being ignited; and the confinement of the oil itself, so that in case of the lamp being upset no considerable portion would find its way out.

Second. In a pecuniary point of view, the value of the illuminating power depends chiefly on the price of the oil, as, for a given consumption of the same oil, the cost does not

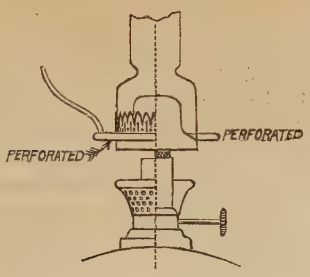
differ much between all lamps of good construction. This, then, is also chiefly a question of oils, not of lamps.

Third. The absence of smell, when a good oil is used, depends wholly on the construction of the lamp. Everyone knows that raising the wick of a lamp above a certain height makes the flame smoke, the reason of which is at once seen, when it is recollected that the wick forms the conductor by which the oil feeds the flame. As therefore a good wick is always drawing up the oil in excess of what is necessary, if too much wick is exposed to the action of the flame more oil than can be consumed is taken up by it, which is therefore given off to the atmosphere in the form of smoke, producing an oppressive smell in a room and also a loss of light. This is somewhat analagous to the case of an ordinary fire-grate, where smoke co-exists with a loss of heat, which undeveloped passes up the chimney, on account of the defective form of the apparatus. In a lamp we do not permit such a state of things, because it would be unendurable; and we are compelled to exact even more from the lamp than a mere absence of a visible smoke, that is to say, we value a lamp by its quality of producing no perceptible smell whatever, and it is considered that this is one of the most important qualities of a good lamp for burning mineral oils.

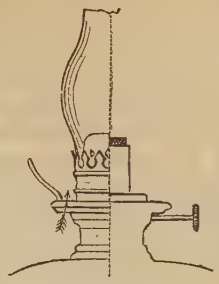
Fourth. The convenience of any lamp for use depends naturally on the purpose for which it is required, and the manufacturer who meets the want by the variety of his forms is most likely to be patronized by the public; but all who use lamps know that the charge for broken glasses at the end of the year is not small, and that it is in taking them off and on for the purposes of cleaning and lighting, accidents mostly occur. All are not equally intelligent or careful, and some lamps would be as great a puzzle to the servant as a philosophical instrument might be to the master, the consequence being dirty lamps or broken glasses.

Fifth. Fortunately, "cheap and nasty" does not necessarily apply to the petroleum lamps exhibited; there are bad dear lamps, and good cheap ones. The steady bright light of a good petroleum lamp may be enjoyed as well by the poor as by the rich man. The manufacturers of England, France, and Germany, have shown that a strong, well-fitting lamp can be turned out at a first cost of under three shillings, with the quality of being capable of doing good service.

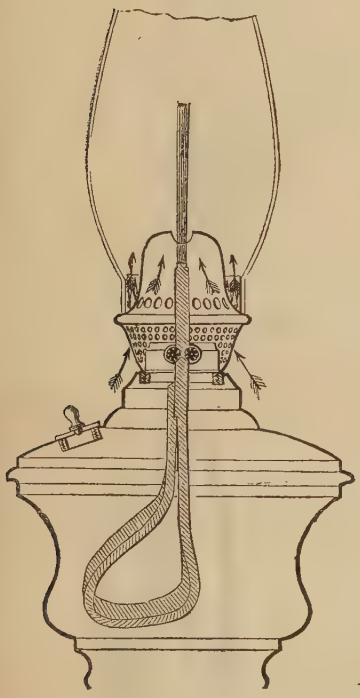
Sixth. As an ornamental object, a lamp can be made to take a high place, and the industry of the artist may be turned to use in producing forms which, when repeated in large quantities, can come within the reach of very limited means.



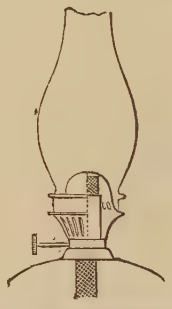

FLAT-WICK LAMP BY STOBWASSER, OF BERLIN.



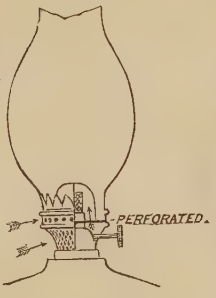
FLAT-WICK LAMP BY YOUNG, OF EDINBURGH.



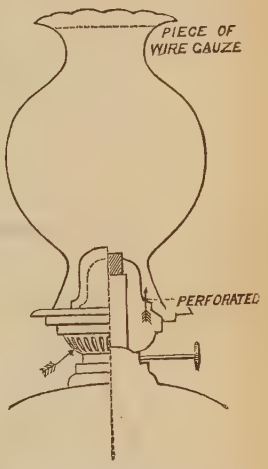
FLAT-WICK LAMP, BY MARMET, OF NEVERS.



FLAT-WICK LAMP, BY BERGHAUSEN, OF COLOGNE.




FLAT-WICK ALADDIN LAMP, BY SULLIVAN, OF JERSEY.




FLAT-WICK LAMP, BY ROWAT, OF EDINBURGH.

Flat-wick petroleum lamps.

Lamp wicks generally may be divided into flat and cylindrical, and illustrations of lamps are given, constructed for each form. As a general rule flat wicks may be considered as best adapted for petroleum, although the light being stronger on one side than another is a disadvantage. With the flat wicks the combustion is more perfect, the danger of vapour from the oil igniting in the tube less, and the construction of

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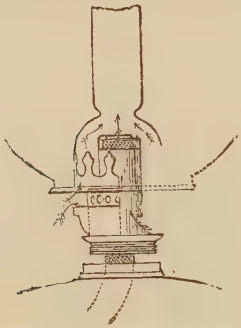
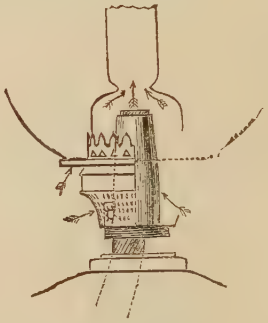
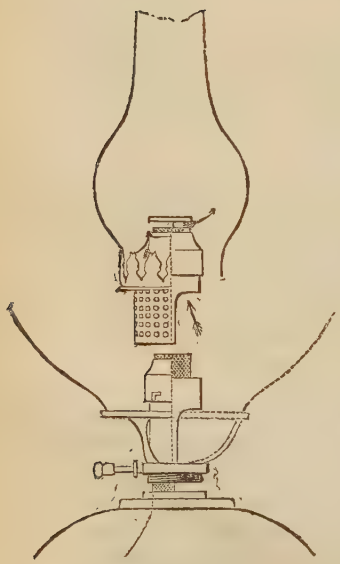
the lamp more simple. It is not intended to condemn the use of round wicks. The lamps of this form exhibited by Messrs. Stobwasser, of Berlin; King, of London; and Young, of Edinburgh, cannot be too highly mentioned; but an examination of the illustrations will show that the supply of air must be deficient, especially in Messrs. Stobwasser's and Young's, producing imperfect combustion. Both these manufacturers endeavour to counteract this by contracting the neck of the chimney, but with a considerable increase of heat, danger to the glass, and very doubtful success as regards the object in view.



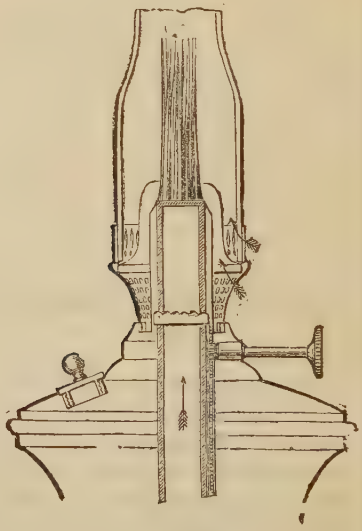
ROUND-WICK LAMP, BY YOUNG.



ROUND-WICK LAMP, BY STOBWASSER.



ROUND-WICK LAMP, BY KING, OF LONDON.



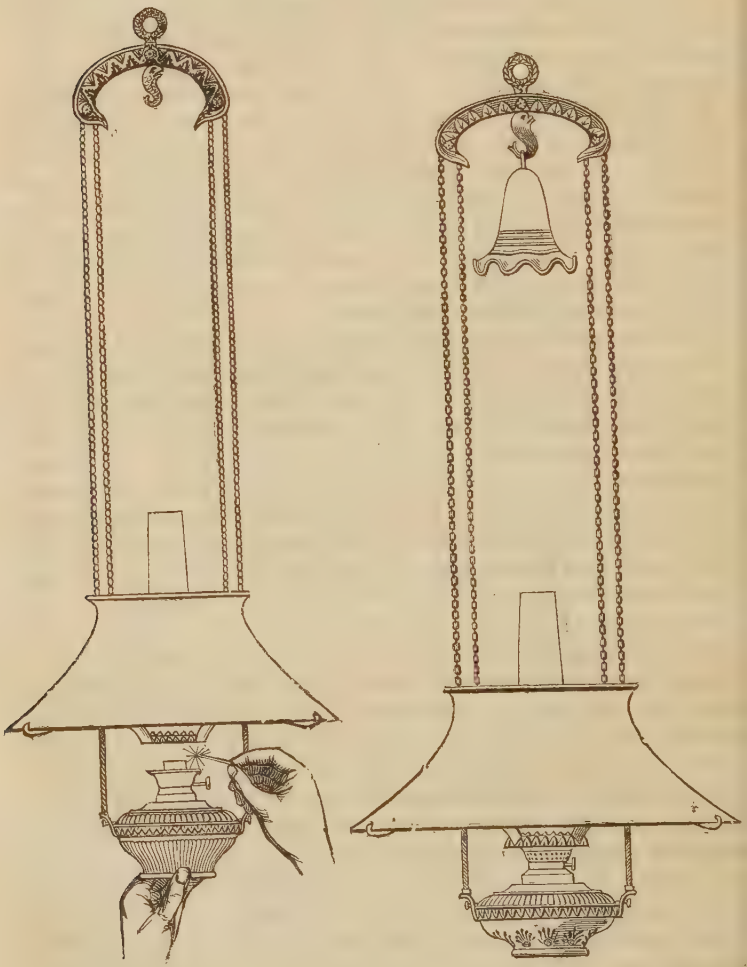
ROUND-WICK LAMP, BY MARNET, OF PARIS.

Round-wick petroleum lamps.

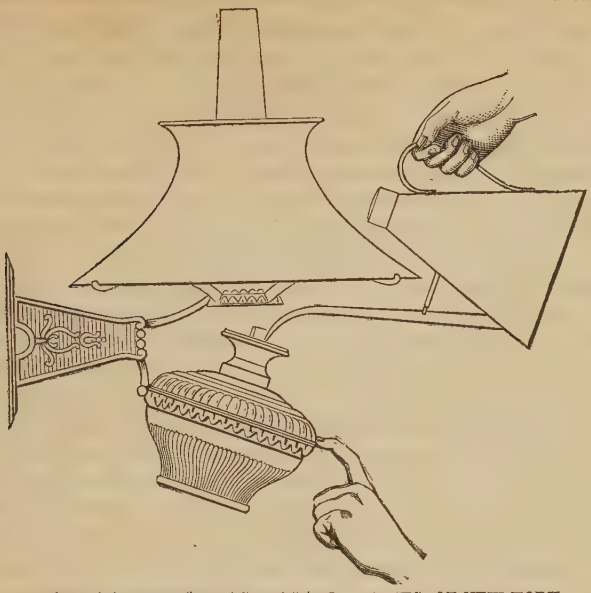
Mr. King's lamp has a more perfect supply of air, and he endeavours to delay its passage at the flame by introducing over the central opening a brass disc, obtaining, probably, as good a result of combustion as the other with less danger to the glass and less heating, but with a considerable loss of light. The disadvantage in Messrs. King's and Young's lamps of having to make a cut in the side of the wick before being able to introduce it, is done away with in Mr. Stobwasser's by the use of a flat wick curled into the tube, which, being in the form of a truncated cone makes the edges meet at the point of ignition. This arrangement of Mr. Stobwasser's appears original and is worthy of remark. Although in some respects not so good as his flat-wick lamp, M. Marnet's small round wick is, for the price, probably the best lamp exhibited. Air is freely supplied to the interior of the flame by the tube which forms the axis of the lamp and which is open at the bottom, consequently the wick is the same and acts in the same manner as in the ordinary moderator lamp. M. Marnet also uses the ordinary chimney of the latter lamp, which, as he says, is more easily replaced than one of a special construction.

Of the flat-wick lamps, not much is to be said of the means of supplying air to the flame as regards any lamp but that of Messrs. Rowat, in which one glass doing duty for chimney and globe allows of a very free circulation of air round the tube containing the wick as far as the flame itself. The simplest lamp is probably that of M. Marnet, which also combines great cheapness with the highest illuminating power. He claims originality in the double ratchet for moving the wick, and also for his plan of doubling the lower end of the wick into the tube, which, he believes, ensures constancy in the quantity of oil supplied to the flame. For simplicity, M. Rowat's compares favourably with those of Messrs. Stobwasser and Young, as his second metal bulb over the flame does the same duty as the lower part of their chimney; but a doubt may be expressed as to its freedom from smell, in spite of the wire gauze covering to the glass. As a good cheap lamp, Mr. Sullivan's with an oblate glass and spring holder, may be recommended, but the workmanship is not what it should be. For convenience of lighting, cleaning, and filling, Mr. Ives of New York, exhibits a lamp (of which two examples are given), but the principle is not original. The price of the bracket lamp is 3·25 dols., and it is well adapted for lighting passages, landings, &c. In their hanging lamp the shade and chimney balance the font and oil, so that for cleaning, trimming, and filling, the latter can be

drawn down, separating it from the former. A perusal of the prospectus of these manufacturers will afford amusement as well as interest; an application for it addressed to 49, Maiden-lane, New York, would probably meet with every attention.



HANGING LAMP, BY IVES, OF NEW YORK.



MODE OF FILLING BRACKET LAMP, BY IVES, OF NEW YORK.

In the few remarks on lamps for household purposes I have confined myself to those especially adapted for mineral oils. As these oils are to be found in almost all quarters of the globe, this fuel for lighting (where gas is not procurable) is likely in future years to be the cheapest and most readily available; hence any comparison of the different methods of burning it will have especial value. All the lamps mentioned (as well as others) have been carefully experimented on in the English testing house, and tabulated results are given, *vide* "Testing House Report."

Experiments with lamps.

While accounts of accidents from the use of mineral oils appear weekly in the newspapers, the public (especially the more ignorant portion) will look with suspicion on this means of lighting; but, assisted by science and legislation, time will prove that in it we possess an inestimable boon to all who are not rich; who, as coal increases in price, will learn that a bright lamp on the table may be fully as cheerful as a blazing fire on the hearth, warmth being obtained by some more economical means.

Mineral oils of inferior quality.

The system of classification adopted by the Imperial Commission has divided the works of some lamp manufacturers amongst four or five classes, such as ships, railways, carriages, &c. Not feeling bound to confine these remarks to those only which its arbitrary rule admits to Class 24, I venture a few on ships' lamps, which, as burners of petroleum, have been adopted in the last few years. The prin-

Ships' lamps.

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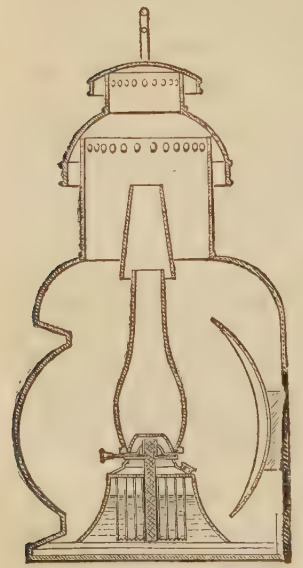
cipal exhibitors of ships' lamps are Messrs. Chastel, of Paris, and Nunn, of London, makers respectively to the French and English navies, the Trinity House Corporation, and Messrs. Wavish and Co., Torpoint, Cornwall. The lamps of the two former burn vegetable, of the latter mineral oil.

That, until petroleum lamps can be safely used, a Government is right in rejecting them for use in its navy is undoubted; but if ever a lamp is produced really answering naval requirements, any hesitation in adopting it would be a rejection of an important means of preventing other accidents on the highway of all nations. The accompanying section of a mast-head lamp shows Messrs. Wavish's arrangement for insuring a good flame in strong wind, and for preventing all chance of the oil being spilt, or of putting out the light by the violent motion of the ship. The former is obtained by an arrangement of chimneys and caps, the latter by dividing the oil font into compartments. In ships plying between fixed stations petroleum lamps of Messrs. Wavish's construction can be easily adopted, as a sure supply of good oil can be kept upon land, and only a small quantity need be carried in the ship. In the navy, however, there is this objection, that even if a Government department could, by a proper system of proof, insure a safe oil, there would always be the difficulty of carrying sufficient for a long voyage which happened to be made in a direction where there are no depôts of supply. To get over this difficulty the Messrs. Wavish are recommended to furnish with every lamp a vegetable as well as a mineral oil burner, so that only in fogs, narrow channels, or crowded seas, a ship need be lighted with the latter. That a company like the Peninsular and Oriental should have adopted its use, upon the suggestions made by Dr. Letheby, is a great recommendation of this means of lighting for ships, and the writer has received a most satisfactory report of the use of Messrs. Wavish's lamps on board a steamer belonging to that company, where for greater safety the oil was kept in one of the ship's boats.



MAST-HEAD LAMP, BY MESSRS. WAVISH, OF TORPOINT.

Railway lamps for petroleum.

For railway purposes the lamps constructed by Messrs. Berghausen and Co. of Cologne, promise (with mineral oil) to be a great improvement on the miserable light which, from false economy, some railway companies make use of in their signals. If a light two or three times more powerful than that in use, with greater economy of consumption and labour, should be the means of preventing even one railway accident a year, the Board of Trade would be fully borne out in compelling its universal adoption, and there is no reason to believe that the advantage is over-estimated. Messrs. Berghausen's lamps are remarkable for simplicity of construction, size of reflector, and finish of workmanship. The oil font is (like Messrs. Wavish's) subdivided, but not in a similar manner.

Moderator lamps.

The use and construction of moderator lamps are too well known, and show so little alteration of late years, that no mention of them is necessary. Those who require the best and strongest are recommended to inspect the exhibit of Messrs. Schlossmacher and Co., 19, Rue Beranger, Paris, whose lamp possesses great facilities for being cleaned.

The moderator lamp, as constructed by M. Deleuil 6, Rue de Pont de Lodi Paris, is now adopted as a substitute for the carcel lamp as the standard of comparison for all means of lighting, when fulfilling certain defined conditions; but M. Deleuil sells this lamp only as a scientific instrument, and not for general purposes. Its use in photometric experiments, with a description, will be found in the "Testing House Report."

## Matches.

As an object easily transported and exhibited at a small cost, the match manufacture is extensively represented in the Champ de Mars. The following countries are represented, viz.:—France, five; Belgium, four; Prussia, one; Hesse, one; Austria, five; Spain, three; Denmark, one; Sweden, two; Norway, one; Italy, three; England, one; in all, 27 exhibitors.

In France, MM. Coignet Brothers, of Rue Bleu, Paris, besides exhibiting chemical products, concrete, heating apparatus, and corn stores, show matches in the annexe close to the Porte de l'Université, which they state are chiefly to be noticed for their cheapness, simplicity, and safety. They manufacture about 300,000,000 a year of matches which ignite only on a special surface, besides other kinds. The wages paid to men in their manufactory are on an average 2*s.* 8*d.*; women, 1*s.* 10*d.*; children, 1*s.* 2½*d.* per day of 11 hours. An examination of Messrs. Coignet's matches does

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not show sufficient care in the manufacture of the amorphous safety matches, which ignite badly, an unfortunate circumstance, likely to induce persons to give up the use of them. These manufacturers might take a lesson also from the Spanish and Italian boxes.

MM. Rimailho Brothers, of 20, Rue Rambuteau, Paris, make about 125,000,000 common lucifer matches a year, besides being manufacturers of lamp wicks and night lights. They exhibit a machine in the French section of the machinery gallery for cutting match sticks, which is capable of turning out 600,000 per hour, served by two children. They employ about 130 persons in matchmaking, of whom the men are paid an average of 3*s.* 9*d.* per diem; women, 2*s.* 3*d.*; children, 1*s.* 2½*d.*, besides about 50 women and children occupied in making boxes. They exhibit two kinds of ordinary phosphorous matches, which ignite easily, one with paraffin, the other with sulphur.

MM. Four and Co. of Marseilles, employ about 600 workpeople, turning out about 300,000 gross of boxes a year. For the manufacture of these, both in wax and wood, the gross expenditure of the house amounts to about 580,000f. a year, giving a cost of production of nearly 1*s.* 7*d.* the gross.

M. Caussemille and Co., of Marseilles, employ about twenty men and 400 women and children, with a gross expenditure on labour and material of about 700,000f. a year. The amount of their produce I have been unable to obtain.

M. Siglé, 22, Rue Rambuteau, Paris, employs about one hundred workpeople in the manufacture of matches of all kinds and prices, with a gross expenditure of about 250,000f. a year. Their "safety" match is not very successful, but it is hoped that in time they will make them as efficient as their cheap sulphur match, which probably defies competition out of Sweden.

In Belgium Messrs. Balthazar, Mertens, and Co., of Lessines, established in 1840 for the manufacture of matches, employ 250 men, 100 women, and 200 children in summer, and 200 more of all classes in winter, the day being of twelve hours, and wages varying from 5*d.* to 2*s.* 6*d.* a day. They produce about 3,000,000 matches a day, having machinery capable of cutting the wood for a much larger quantity. They have the right to manufacture the anti-phosphorus safety match of M. Londstrom, of Sweden. Their ordinary sulphur-phosphorus match ignites too easily, and is consequently somewhat dangerous; but those called

"safety" matches, of amorphous-phosphorus and paraffin, ignite and burn very well.

M. Guillaume Mertens, of Overbulaise, employs 700 workpeople and manufactures several kinds of wood matches. His ordinary matches also possess the fault of igniting too freely.

MM. de Roubaix, Adenkoven, and Co., of Anvers, exhibit matches of wood and wax. They employ about 150 workpeople.

From Waldmichelbach, in Hesse, MM. Mœllinger and Wagner send the products of a manufactory which employs forty men, twenty-four women, and a large number of children. They show all descriptions of matches; those called "Phosphor-und Gift-Freie" are original, being almost of the nature of "safety." When rubbed on the box they require a brisk motion, and, after igniting with a slight flash, the sulphur burns quietly.

Austria exhibits the products of one of her largest manufactories—that of M. Zarzetjki, of Pesth, who employs 400 men and 800 women and children, producing 14,000,000 matches daily.

This industry, one of the most important in Hungary, is also represented by MM. Leitner and Grünwald, of Pesth, who employ 200 persons, chiefly women and children, at piece work, gaining from 5*d.* to 8*d.* per diem. They turn out 2,625,000,000 matches per annum, the wholesale price of which varies from between 500 to 1,300 matches for 1*d.* Hungary has in eighteen years increased the number of her match manufactories from two to twenty-four, and transports a large proportion of the products eastward.

Besides the above, Austria is represented by MM. Forster and Wavra, of Vienna, who employ 172 workpeople in their shops, and 150 invalid and aged people at their own homes, producing about 2,000,000,000 per annum, MM. Gœall and Co., of Barn, in Moravia, who employ 250 workpeople, and produce 15,000,000,000 matches a year; and M. Berg, of Cracow, who employs over a hundred people, with a proportionate production.

Spain sends three exhibitors, two of whom are from Tarragona. First, MM. Lizarbe and Son, who employ twenty-five men, twenty-five women, and one hundred children, who produce about 1,800,000,000 matches a year; and, second, M. Dionisio Lasa, who employs eighty-four women and twelve men, who work twelve hours a day, at an average wage of 9d., producing about 1,000,000,000 matches per annum. These are principally small wax

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phosphorus matches, which do not ignite too easily; but from the nature of the wax they burn with much smoke.

Ramon Mayoral, of Caceres, also exhibits matches from his manufactory, where he and his eight sons direct thirty male and female workpeople, who work from sunrise to sunset, gaining 8*d.* to 10*d.* per diem, and producing about 150,000,000 per annum.

Denmark has one exhibitor, M. Mathieson, of Aarhaus, who employs twenty-three persons, mostly children, and produces 120,000,000 per annum.

Sweden being the country which produces the well-known "Tändstückers," is well represented by the "Match-making Company" of Jœnkœping, established since the year 1847, and now managed by Mr. B. Hay. The capital of this company is 22,000*l.*; it employs 620 people, and produced 45,698,241 boxes in 1866, of which about 30,000,000 were exported to England, and sold through the agency of Messrs. Bryant and May. Their produce consists of ordinary sulphur and phosphorus matches; safety-matches, with red phosphorus on the box; and, lastly, of matches without phosphorus, called by them "allumettes-kali." The processes for the manufacture of this last kind of match was patented last year, and, if successful, is likely to do away entirely with the use of phosphorus. The price varies from 1*s.* 6*d.* to 1*s.* 9*d.* a gross. All the matches exhibited by this company ignite well and surely, and those called kali appear to be very perfect, and, it is to be hoped, will eventually take the place of all other kinds.

F. Körner and Co., of Gothenburg, Sweden, employing 300 people, produce 30,000,000 of boxes a year, making various kinds of matches, including "the allumettes-kali," above mentioned. Their price for ordinary matches is 1*s.* 3*d.* to 2*s.* 10*d.*; for safety matches, 5*s.* 7*d.*; kali matches, 4*s.* 9*d.* the gross boxes.

In Norway, M. Sundt, of Nitedal, Christiana, employs sixty-six persons, producing eight or nine millions of boxes a year. The wages per diem amount to about 2*s.* for men, 1*s.* 2½*d.* for women, and 8½*d.* for children. The children are obliged to attend school two days a week. Some children can make 1*s.* a day boxmaking. The prices of the matches vary between 1*s.* and 8*s.* 4*d.* the gross of boxes.

From Italy, MM. Luigi and Segré, of Florence, exhibit matches of all sorts. They employ forty people. M. Longi Santroi, of Empoli, in Tuscany, employs fifty persons, producing about 3,000,000 boxes a year, at an average price of 1*s.* 6*d.* the gross of boxes. This manufactory has been

established in Tuscany since 1839. M. Balthazar Pierini, of Florence, states that he has invented and patented a new *safety* match, which is made without phosphorus. He employs seventy persons; but, owing to alterations in his factory, is not producing the full quantity.

England is represented by only one match manufacturer, Messrs. Bryant and May. A very interesting account of this manufactory has been written by Henry Mayhew, in his "Shops and Companies of London, and Trades and Manufactories of Great Britain." Their success in the manufacture of safety matches alone entitles them to the thanks of the community. They have most successfully followed up and perfected Böttge's principle, in which the amorphous phosphorus is contained in the rubber, so that friction with any other surface does not ignite the match. They exhibit Tändstückers, (imported by them from the Jœnkœping Company, in Sweden); wood "safety" matches, damp-proof Victorias, wax and safety fusees, some of which have porcelain sticks, which proves stronger than wood. All their produce ignite surely and well; and with the exception of those from Jœnkœping, have no sulphur.

The writer has given information in the above list which may be styled incongruous. His only excuse is the difficulty he experienced in obtaining replies, to his letters addressed to the exhibitors, which gave the information he had asked for. Not much information existing about this branch of industry, he thought that such as was collected ought to be recorded, perhaps to be made use of as an assistance to further enquiry on a future occasion.

Former reports on matches.

The official reports on this subject for the Exhibitions of 1855 and 1862 have so completely reviewed this manufacture that any mention of its details could be but a repetition of what has been already written. In the last, Dr. Hoffman, in his report on "Chemical Products," expresses a hope that before the following Exhibition, a match totally without phosphorus would be produced. The "kali match," it is to be hoped, will satisfy this wish. Only lately the expediency of using "safety" matches was impressed on all Europe by the fatal accident to an Austrian Archduchess. The Paris Exhibition, it is feared, only shows that manufacturers are generally directing their attention more to cheapness than safety; and, instead of fulfilling Dr. Hoffman's hopes, have to be *now* reminded that not only ought the use of phosphorus altogether to be given up, but that "safety" is the *first* element in a good match.

## CONCLUSION.

Class 24, mode of classifying objects.

Visitors to the Exhibition will find in their examination of the portions allotted to Class 24 that very many of the objects exhibited under the terms "heating and lighting" are chiefly remarkable for their ornamental character, and for the excellence of the workmanship which has been expended on their decoration. It has thus happened, that an object such as an ordinary fire-grate or chandelier, possessing great merit as a piece of ornamental metal-work, but having no claim to notice as an appliance for heating or lighting, has been exhibited in Class 24. In some cases an exhibitor, who has no pretension whatever to originality or excellence in that respect, finds himself in a class where the beauty of his workmanship claims but little attention. In one or two cases in the French section manufacturers of lamps have exhibited in two classes, in one for their excellence as lamps only, in the other as ornamental objects, thus submitting the same object to the opinion of two juries; and receiving, where they excelled in both respects, the full award which was their due.

Utility and not ornament.

That utility and not ornament was the intention of the classifiers of the Imperial Commission two circumstances will prove: one, their printed description of the objects proposed to be embraced by the class; the other, the qualities of the men selected to serve on the jury.

The only way to have avoided the difficulty caused by this mode of classification was to have placed the manufacturer in whichever class he desired to compete, or in both.

Exhibitors in a wrong class.

Unfortunately it was not unfrequently found out, too late in the day, that the exhibitor's specialty really lay in a direction not embraced by the class to which he had been allotted.

In consequence great labour was imposed on the jury in their desire to do justice to the exhibitor, and at the same time to preserve the landmarks laid down for them; not unfrequently resulting in serious anomalies.

Ornamental characteristics not noticed.

But the writer of this report, not being guided by, or confined to, the same rules, has been enabled to confine himself almost exclusively to a notice of objects which commend themselves for their utility, and in which ornament is not the first object.

He has been induced to do this by no desire to depreciate the value of the objects as works of art, but through a fear of not being able to do justice to them as such. It will be

found, in consequence, that many who are entitled to high commendation, and whose names are to be found in Class 24, have been here omitted.



"Gas apparatus" and "apparatus and accessories for lighting by gas" are amongst the objects included by the Imperial Commission in Class 24. Guided by this description many of the commissions have included in it exhibitors of gas holders, regulators, meters, photo-meters, and so forth, losing sight of the overruling fact that Group 3, to which Class 24 belongs, is only intended to contain objects strictly required for the purpose of dwelling-houses. Thus tied, the jury was again obliged to use much discrimination, and eventually considered itself obliged to confine its examination to gas-burners only.

Lighting by gas.

A reporter being free from the same restraint, may therefore more widely interpret the term "gas apparatus." But, as many of the objects that came under the writer's observation were experimented on in the English testing house, it has been considered advisable to leave all mention of them to the following "Testing House report."

Capt. Webber on Testing House.

# THE TESTING HOUSE REPORT.

First Section by Captain Webber, R.E.

Second Section by Captain Webber and Mr. W. T. Rowden.

## Section I.

A building for experimental purposes required.

In former Exhibitions the want of some place where experiments on certain classes of objects might be carried on, had been frequently felt. Sometimes jurors were unable to test the comparative merits of articles coming under the same *genus*. At other times commissioners or exhibitors, desirous of bringing into close comparison the products of various countries, were disappointed for want of some convenient and safe space within the Exhibition in which to carry out their proposed trials. This want was more especially felt in the case of apparatus which consume gas and coal, and in which any real test of merit was impossible without a practical trial.

Gas apparatus in machinery gallery.

In the case of gas apparatus, the Imperial Commission had provided that every facility should be given for their being seen at work in the Machinery Gallery. But many objects for lighting purposes were exhibited in the Industrial Gallery, and it was obvious, that they, as well as all heating appliances, must be shown in the ordinary way.

Effects of the manner of classification adopted.

By classifying together heating and lighting apparatus for the purposes of dwelling-houses, the Imperial Commission assembled objects which had in previous Exhibitions been scattered in various directions. Stoves and cooking ranges were only to be found amongst hardware. Lamps and lighting apparatus in the various departments of industry in which their makers happened to exhibit. The bringing such objects together was certainly a gain to the visitors, and indirectly in consequence, an advantage to the manufacturers; but in many cases at a sacrifice to the *tout ensemble* of the *exhibit*, when the exhibitor was obliged to distribute his goods in more than one place.

This difficulty was not felt so much by French exhibitors, who were able with advantage to themselves to show a very considerable number of articles of the same kind.

French annexe for exhibitors in Class 24.

In order that objects in this class should be exhibited in large numbers, the Imperial Commission erected in the

French part of the Park a large annexe, and offered every encouragement to the erection by individual exhibitors of small and ornamental buildings for the same purpose. This privilege was extensively made use of, so that in addition to a considerable space in the Palace, Class 24 was well and largely represented outside. In some cases manufacturers exhibited both inside and in the annexe, in others in only one or the other place. The consequence was that this class was one of those most largely represented in the French section, forming a completely new feature in Exhibitions, in which all that concerned the warming, lighting, and ventilating of public and private buildings was brought together.

The English testing house.

The United Kingdom alone, amongst foreign powers, attempted to promote the project, and, in the space allotted to Class 24 in the Palace and in the Testing House in the Park, brought together a collection of objects, which, though small in numbers, were certainly not inferior in quality to anything of the kind exhibited by our neighbours.

Its origin.

But it was left for the British Commission to originate the idea of exhibiting a large number of these objects in action, and it was on the invitation of the Imperial Commission to fill the space allotted to England with appropriate buildings, that it was proposed to carry out the idea, already in germ in some minds, of having a Testing House.

Its object encouraged.

It was to be hoped that great public benefit might be derived from such an undertaking. Already had the authorities at the War Office and the Admiralty shown themselves anxious to improve the sanitary condition of the abodes of our soldiers and sailors, and in some respects were in the advanced guard of the march of improvement. Philanthropy was doing much towards the amelioration of the conditions under which the poorer classes warmed and lighted *their* dwellings. Private individuals, amongst whom were foremost Mr. Edwin Chadwick, C.B., and Mr. Twining, were already urging the necessity of a well-directed inquiry into the subject; and the Society of Arts, first in all such undertakings, had already lent its voice to show the necessities and wants of the million.

To further this object, and in order that it might receive a proper amount of consideration, a special Committee was appointed, consisting of the following members, viz.:—

Testing Committee.

Professor Frankland.
Edwin Chadwick, Esq., C.B.
S. Twining, Esq.
Rear-Admiral Ryder.
Captain Phillimore, R.N.

Capt. Webber on Testing House.

Lieut.-Colonel Lennox, R.E.
Captain Pelly, R.E.
Captain Donnelly, R.E.
Captain Festing, R.E.
Captain Hoare, R.N.

to which Committee the writer acted as Secretary.

Want of success in inducing manufacturers to exhibit.

This Committee met several times, but unfortunately the manufacturing public failed to appreciate the advantages offered, and it was found that with a few exceptions the greater number of proposals from persons desirous of exhibiting were of such a nature that it would have answered no useful end to have afforded them space for their inventions.

As it was desirable that British manufacturers of this nature should be very fully represented, nothing was left undone, both by advertisement and by direct application, to induce makers to forward worthy objects for exhibition, and the Committee exerted itself in many ways to obtain such a result, but with very little success.

Space in testing house filled with objects in Class 65.

It being impossible therefore, to fill all the space available in the Testing House with objects in Class 24, the remainder was given to exhibitors in Class 65, who, as makers of material and appliances for building purposes, were brought into the same category as Civil Engineering and Architecture. This was more especially appropriate as all available space on the outside of the building had already been given to the same class. Thus it followed that the Testing House afforded means of exhibiting to 60 English producers whose goods would otherwise have been excluded for want of space; and in many cases in a way which would have been quite impossible in the interior of the Palace.

Sixty exhibitors in testing house.

Testing house useful in various ways.

Although not answering in every way its original intention, the Testing House proved in many respects a very useful "*Annexe*" to the British section. As illustrative by its form of a certain kind of domestic architecture in England, it was an appropriate building in a Park which boasted of examples of dwellings from every land. As a substantial edifice it allowed of cooking, warming, and lighting appliances to be practically tested without danger of accident. And as a construction it enabled the Commission to accept from producers many kinds of building material as voluntary contributions, which in this way were exhibited, at a very much less expense to the lenders, and in a manner in which the merits of the objects could be favourably judged of.

Difficulties in connexion with its erection.

If the building failed to present the appearance which might be expected from one so prominently situated, it must be borne in mind that it was erected under circumstances

in which an architect is very rarely called to act; that is to say, to use in his building, material however incongruous of all kinds, with little power of selection; the said material arriving on the ground, in many cases, within a few days of the time when it was expected that the building should be completed. CAPT. WEBBER ON TESTING HOUSE.

Added to this, owing to a failure in the contract, the shell of the house was not ready until the end of January, and it was only by the greatest exertion, in the face of difficulties of all sorts, of which bad weather was not the least, that the outside was made to present a tolerably finished appearance by the 1st of April.

Importance of spreading information on subject of heating and lighting.

The few experiments carried on by the writer in the Testing House, during the short time his other duties allowed him to give to that work, have left one strong impression on his mind, which is, of the importance of a more widely diffused knowledge amongst all classes as regards the economical use of the appliances which the Imperial Commission had allotted to Class 24, resulting in a desire to have an opportunity of not only repeating the trials more carefully and with a better defined object, but also of extending the researches in the same direction for the purpose of establishing well defined principles, not only for the guidance of consumers, but also as an assistance to producers.

Further experiments desirable.

Desirable that trials be carried on under authority of some public body.

Manufacturers' prospectuses are filled with the results of experiments made with their appliances, accompanied by testimonials not only from private individuals, but also bearing the names of well known scientific men. Many of these are honestly obtained, and are the conscientious opinion of persons whom to know would be to trust; but in the face of the temptation which exists to bring forward one-sided or distorted evidence, the public will invariably view with suspicion all such means of advertisement.

It is, therefore, only in the power of the public service, or of some well known scientific body, to form a tribunal which will inspire trust in the minds of persons desirous of obtaining unbiassed evidence of the merits of those objects which enter into the economy of daily life.

Practical illustrations necessary.

In addition to this, visual evidence of facts is required, and no people is so capable of instruction by such means, or requires it so much, as the British public. In these days of instruction by means of the press, would-be teachers are too often satisfied with words instead of deeds, and "tracts" on economy are frequently left at the doors of cottages and humble dwellings to astonish and excite the wonder of the occupants, but too seldom to inspire them with any desire to do likewise.

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Its value in testing house.

The writer recalls how often he has seen a crowd around some cooking range in the English Testing House, which, with glowing fire, turning jack, and steamers at work, illustrated to the continental housewife the use of an English apparatus, which if seen otherwise, was passed by with indifference. And now he thinks, that in extending our Art collections to other great towns, domestic Science may also have a place, and that while lifting the minds of our handiworkers to the beautiful in the one, we may also turn their attention to the useful in the other, with equal benefit to the nation.

Its value as an aid to persons desirous of improving the homes of the poor.

Then the philanthropist will be encouraged in his efforts by such practical evidences, which he may point to as examples, of how the food can be better cooked, and the dwelling can be better lighted and warmed. And as the crowd of sight-seers passes amongst objects which in most but excite feelings of curiosity and amusement, it will also be reminded, that an Englishman's efforts are best directed when used to ameliorate his condition in that spot which in no country can be so truly called "Home."

Private consumption of gas.

For instance, in the lighting of our houses by gas it is notorious that the consumer is generally ignorant of the manner in which his gas bill is calculated, and rather than fathom its mysteries he places entire trust in means of control which only profess to guard him against extravagant charges.

Every consumer of gas could easily be made to understand the advantages to be derived from a sure means of measuring his supply and an economical way of using it, and it is by illustration and comparison that he will be best shown how easy it is to become his own guardian in the matter. He can soon learn that even with the best meter, accidents and time will produce a false registration, or that with burners, valuable with one kind of gas, great waste may be going on with another.

Public consumption of gas.

To turn from this part of the subject to that which affects the public as a body, we have only to recollect, that at this moment a Parliamentary Bill, by which gas companies would be compelled to act more in the interest of the consumer than heretofore, is in abeyance, to show that a more widely diffused knowledge is required, of what we have right to expect from those who profess to serve us. A knowledge, taught by practical illustration, which would cause a pressure of public opinion to be brought to bear on the interests that impede progress.

Paris and London.

The writer cannot help drawing a comparison between the lighting of Paris and London, in illustration of the difference

between the result of municipal censorship, guided by science and common sense, and public opinion swayed by local and other interests, conscious of being badly served, but ignorant of any means of correcting the evil. CAPT. WEBBER ON TESTING HOUSE.

In London we have several companies each with its own district. In each we find a different price, quality, illuminating value, pressure, &c.; and all these conditions affecting variously the consumption, under circumstances generally unknown to, and therefore beyond the control of, the private consumer, resulting in mistakes, complaints, and many misunderstandings. Again, under deficient supervision, we have no certain redress for frequent changes within the limits of the conditions prescribed by Parliament, and dividends are increased at the expense of the ratepayer. The public lighting which should be the most perfect and the cheapest of any town in Europe, is in many localities noted for the contrary qualities, and divided responsibility leaves conservancy, administration, and extension in the hands of those who only seek for economy so far as it affects their own interests. In Paris we find the prefects of the Seine and police on the one side acting in the interests of the public, and on the other, one company; which, although having the concession for the whole town, is so completely under the control and supervision of the concessionists, that a due regard having been paid to the interests of the shareholders, the greatest advantages that an economical application of scientific means can obtain, are gained for the consumers. Lighting of London. Lighting of Paris.

Nothing can be more definite and stringent than the conditions under which the company is bound, and the following are only the most important advantages which are obtained:—

The removal of all Works outside the precincts of the town. The complete connexion of the whole system of supply, so that in case of accident or destruction of any one of the Works, the lighting of the contiguous district is not suspended. A definite standard of illuminating power and purity, which is nightly checked in every district of Paris. The power on the side of the concessionists to call on the company to adopt any improvement in science which tends to economise the consumption, and even to repudiate altogether the contract in the event of any new system of lighting being discovered. A control by the administration of all alterations and extensions in the public lighting, and, in fact, of every condition under which the gas is supplied.

To insure the fulfilment by the company of all these conditions the fullest powers for exacting the penalties agreed on, are given to the administration; and these penalties are

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of such a serious nature, even for the most trifling neglect, that the company cannot incur them with impunity.

The reader interested in these matters will find the fullest information in a pamphlet entitled "Services public et particulier de l'eclairage et du chauffage par le gaz dans la ville de Paris," published by Charles de Mourgues Frères, 8, Rue Jean Jacques Rousseau, Paris.

Of course in England objection would be taken to many of the conditions of supply, such as the difference of price to public and private consumers, but when we look to results it must be conceded, that in proportion to the price of coal, Paris is much better and more cheaply lighted than London.

Necessity for public opinion to carry out and aid legislation in England.

From the preceding few remarks on the gas supply of London and Paris, which in some cases may be also applied to other towns, it will be gathered that the writer conceives, that much improvement might be effected by legislative enactments on the subject, for which opinion he gives as authority, the Report in 1865 by Mr. Haywood and Dr. Letheby on the "Gas Supply in the City of London." He also believes that the instruction of the public, as a preparation for legislation, is of the highest importance, more especially in a country like the United Kingdom, where in most cases Parliament is slow to move until a want is felt to be pressing, and not only is public instruction required for the above reason, but also for the purpose of promoting a knowledge of what can be even now claimed by law from the gas companies of the country.

That the Testing House at the Paris Exhibition of 1867 can be considered as a good example of such an instructional museum is not here supposed, for the very fact that it was used also for actual experimental purposes, precluding its full development as an exhibition.

Trial of English and American safes.

Even should little of practical utility have been educed by the results of experiments which follow, the Testing House, as has been shown, bore its share of the work in other ways; and even, on occasions, proved a useful meeting ground for interesting trials of one kind or another. Amongst them one which will be long remembered, was that between the English and American safes.

Mr. Rowden.

During a portion of the time that the Exhibition was open the writer received the valuable assistance of Mr. W. T. Rowden, who has compiled that portion of this report which refers to lighting apparatus and warming stoves.

Sergeant-Major Laverty.

Serjeant-Major Laverty, chief instructor in cooking at Aldershot, conducted a series of trials with the cooking apparatus, the results of which, as registered by him, are compiled in some of the following tables.

During the whole period that the Exhibition lasted all the appliances exhibited in the Testing House that were capable of action were shown at work, and the arrangements were so made that each object could be thus seen at least twice every week, descriptive printed notices being posted throughout the Champ de Mars. Upon George Rooke, of the South Kensington Museum, and Sapper Nellis, of the Royal Engineers, devolved this latter duty, which was regularly and carefully performed.

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G. Rooke and Sapper Nellis.

## Cooking Apparatus.

It cannot be said, after a perusal of the following accounts of trial, that any, except perhaps that with Messrs. Barton's range and some of the smaller appliances, will afford very instructive information. In two cases, "Captain Warren's" and the "Married Soldier's Range," ample trials had already taken place at Aldershot. And the ships' hearths of Messrs. Benham and Bowser were already in use on board British vessels, where they could be worked under even more favourable circumstances. Trials of this nature must be carried on with some well-defined object in view, in order to be instructive to anyone who has not been present, and in order to draw just conclusions. It may be said that this was done in the case of Messrs. Bowser's ships' hearth, where, in respect to one point of importance, it was found, after successive trials each more successful than the last, that the boilers could be raised to 212° F. in 1½ hours after lighting the fires. But generally it will be seen that there is a want of definite purpose in the experiments, resulting in returns from which but very general conclusions can be drawn. It is therefore more to be regretted that some member of the Committee, originally appointed to bring these objects together, was not found able to give his personal superintendence to them. However, it is possible that good will result by the mere fact of the attempt having been made, by showing the necessity of a more careful and extended practical examination into such matters.

To this period it may be said that the cooks have had it all their own way. Possibly in future much that has hitherto been a matter of individual skill and judgment, may be governed by simple rules so far as concerns the *mode* of subjecting food to the action of heat in its preparation. Many may not have read Lady Llanover's little work entitled "Good Cookery," which the writer cordially recommends to the perusal of all mistresses of households; and he con-

Modern cookery.

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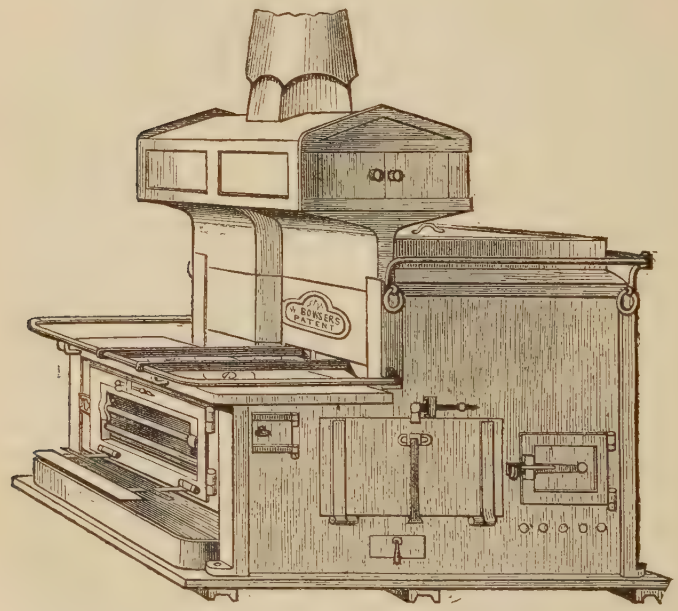
ceives that it might be usefully supplemented by a few practical hints derived from experiments such as those which have been carried on at the English Testing House. The reader will concede that few subjects are of greater domestic importance, and that by a few aids and a little guidance a lady interested in her kitchen affairs may bring her superior education to bear on them, so as to have a real control over the administration of a realm, at present firmly held, in too many cases, by a usurper styled "the cook."

The coal used in all the trials made in the English Testing House was "Newcastle," of the species known as "Cherry."

*Fire Hearth for the Navy.—Messrs. W. Bowser and Son, London.*




W. BOWSER AND SON'S SHIP'S FIRE-HEARTH FOR THE NAVY.

This apparatus covers 16 square feet of ground space, contains two fires, one an ordinary range fireplace with hot plate, the other a furnace under the boilers. There are two large ovens between the fires, and two boilers over the furnace, holding respectively 28 and 25 available gallons of

water. In the lower part of the illustration are shown, the front of the open range fireplace, one of the large oven doors and the furnace door; above the latter can be seen the lid of the boiler on that side. The upper portion of the apparatus consists of a small oven, and boiler containing 7 gallons, attached to the flue.

The area of the bottom of the ovens is 12 square feet, of the shelves in ovens $6\,{}^{3}_{1}{}^{3}_{2}$ square feet, and of the hot plate 9 square feet.

TABLE I.—EXPENDITURE of FUEL and STATE of BOILER.

| Number of Experiment. | Length of Experiment in Hours. | Fuel supplied. | | | | Two large Boilers. | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | Time from Commencement of Experiment. | Wood. | Coal. | Total Fuel. | Time after lighting at which Water in Boilers boiled. | Time allowed to boil. | Total evaporation. | |
| | h.m. | h.m. | lbs. | lbs. | lbs. | h.m. | h.m. | galls. | |
| 1 | 9·30 | 0 | 4·4 | 55 | — | 3. | 6.30 | 24 | |
| | | 4 | | 30·8 | | | | | |
| | | 4.45 | | 22 | | | | | |
| | | 6 | | 40·7 | | | | | |
| | | 7 | | 21 | | | | | |
| | | 7.45 | | 30·8 | 204·7 | | | | |
| 2 | 8· | 0 | 7·7 | 55 | — | 2.30 | 5.30 | 17 | Only the furnace fire lighted. |
| | | 1 | | 22 | | | | | |
| | | 2 | | 17·5 | | | | | |
| | | 3 | | 18·7 | | | | | |
| | | 5 | | 22 | | | | | |
| | | 6 | | 30·8 | 173·7 | | | | |
| 3 | 10·15 | 0 | 13· | 66 | — | 2.15 | 8 | 20 | Each fireplace was charged with the same amount. 57 gallons only in boilers. |
| | | 1·15 | | 33 | | | | | |
| | | 3 | | 33 | | | | | |
| | | 7 | | 33 | | | | | |
| | | 9 | | 33 | 211 | | | | |
| 4 | 12 | 0 | 11 | 66 | — | 2. | 10 | 39 | Ditto. |
| | | 1 | | 17·7 | | | | | |
| | | 2·45 | | 17·7 | | | | | |
| | | 3 | | 17·7 | | | | | |
| | | 5 | | 33 | | | | | |
| | | 7 | | 33 | | | | | |
| | | 8·30 | | 17·7 | 213·8 | | | | |
| 5 | 9 | 0 | 13·3 | 66 | — | 1.30 | 7.30 | 24 | The range fire was lighted 30 minutes after the furnace. |
| | | 3 | | 17·7 | | | | | |
| | | 4 | | 17·7 | | | | | |
| | | 6 | | 33 | | | | | |
| | | 8 | | 17·7 | | | | | |
| | | 9 | | 17·7 | 183·1 | | | | |

Capt. Webber on Testing House.

Table II.—State of Ovens and Results of Cooking.

| Number of Experiment. | Time from Commencement. | Temperature of Large Ovens in degrees Fahrenheit. | | Meat cooked. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | No. 1. | No. 2. | Raw. | Cooked. | Loss per Cent. | |
| | h.m. | | | lbs. | lbs. | lbs. | |
| 1 | 0 | 71 | 71 | — | — | — | The temperature of the small ovens rose in the same time to 300° F. |
| | 1 | 99 | 100 | | | | |
| | 1.30 | 120 | 110 | | | | |
| | 2 | 190 | 170 | | | | |
| | 2.30 | 270 | 200 | | | | |
| | 3 | 340 | 300 | | | | |
| | 3.30 | 390 | 370 | | | | |
| 2 | 0 | 65 | 65 | — | — | — | On this occasion only one fire being lighted it took 4 hours to raise the ovens to 300° F. |
| 3 | 0 | 65 | 65 | — | — | — | ——— |
| | 1.30 | 290 | 290 | | | | |
| | 3 | 335 | 350 | | | | |
| | 3.30 | 400 | 400 | | | | |
| 4 | 0 | 70 | 70 | 24·2 | 20·9 | 13·7 | The temperature in the ovens was maintained until the close of the trial. |
| | 1 | 120 | 120 | 18·7 | 11· | 40· | |
| | 1.30 | 220 | 220 | 14·3 | 9·9 | 30·7 | |
| | 2.30 | 250 | 390 | 46·2 | 33· | 28·5 | |
| | 3.30 | 400 | 400 | 12· | 7·7 | 35·8 | |
| 5 | 0 | 60 | 60 | — | — | — | In this trial the temperature rose to 400° F. in the ovens 2 hours after lighting of furnace. |

The fifth trial may be taken as a fair estimate of what the apparatus is capable of doing, and there can be no question that the results are remarkably good.

In addition to the above, it should be stated that the range fire was ready for roasting in two hours, and the hot plate for frying or stewing within one hour and a half after lighting.

The small boiler containing seven gallons is only intended to afford a supply of water heated to about 150° Fahr., which it does effectually.

Messrs. Bowser claims for this apparatus that it is capable of cooking for a ship's company of 140 officers and men, but they may with safety claim equal advantages for a larger number.

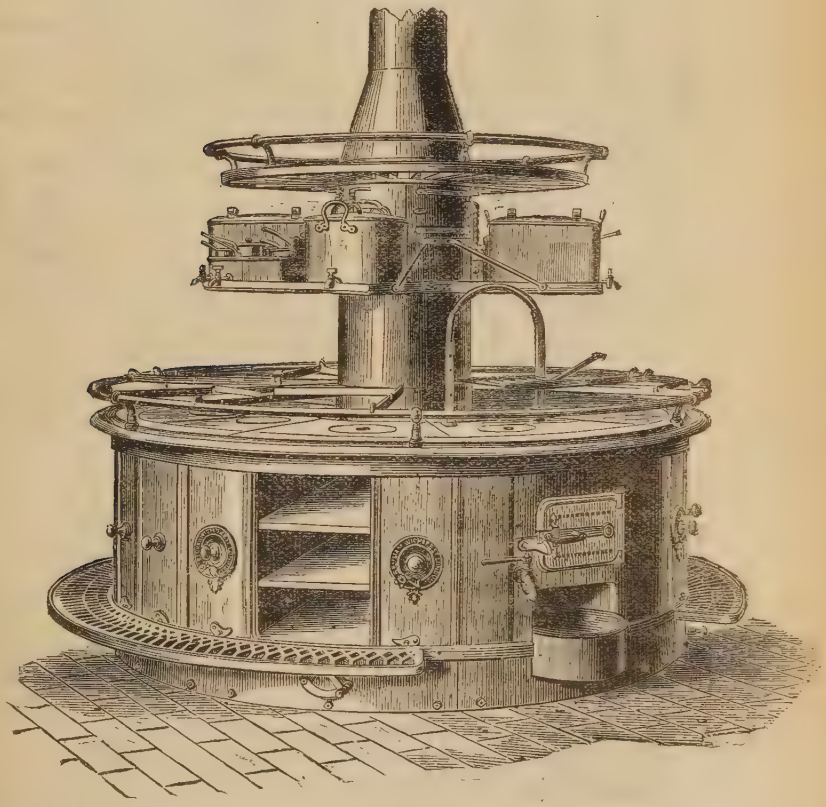
The apparatus is extremely compact, and can be worked with comfort to the cook. And the general arrangement of the flues and heating surfaces is effectual in preventing a waste of heat.

It is defective in not utilizing the steam from the boilers with which a large amount of work could be done.

The great waste of meat shown in Table II. is due to the ordinary mode of cooking in ships by stewing in the large boilers.

The workmanship is of the highest order, but double plates between the fires and oven are required.

*Circular Ships' Patent Fire-hearth.—Messrs. Benham and Sons, Wigmore Street, London.*



SHIP'S PATENT FIRE-HEARTH, BY BENHAM AND SONS, LONDON.

Description. This apparatus is seven feet in diameter, contains two furnaces which are situated on opposite sides, four large

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ovens with sliding doors, and a boiler containing 30 gallons, which communicates with a supply cistern. The smoke (*vide* cut) ascends in the middle, and its casing supports shelves for the steamers of all sizes, which receive their supply from the boiler. The hot hearth, which is very extensive, is guarded with a railing to prevent the pans falling off from the movement of a ship.

TABLE I.—EXPENDITURE of FUEL and STATE of BOILER.

| Number of experiment. | Length of experiment in hours. | Fuel supplied. | | | | Time after lighting at which water in boiler boiled. | Time allowed to boil. | Total evaporation. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | Time from commencement of experiment. | Wood. | Coal. | Total fuel. | | | | |
| | h.m. | h.m. | lbs. | lbs. | lbs. | h.m. | h.m. | gal. | |
| 1st | 6·30 | 0 | 4·4 | 35·2 | | 2·45 | 3·45 | 14 | The number of the trials correspond with those in Table II. |
| | | 3·30 | | 19·8 | | | | | |
| | | 4·15 | | 19·8 | | | | | |
| | | 5·0 | | 19·8 | | | | | |
| | | 5·30 | | 19·8 | 132·2 | | | | |
| 2nd | | | | | | | 4·0 | 12 | |
| 3rd | 7·15 | 0 | ·44 | 33· | | 3·15 | 4·0 | 15 | |
| | | ·30 | | 35·2 | | | | | |
| | | 1·15 | | 22·0 | | | | | |
| | | 2·15 | | 44·0 | | | | | |
| | | 4·15 | | 22·0 | | | | | |
| | | 5·15 | | 22·0 | 182·6 | | | | |
| 4th | 8· | 0 | 6·6 | 44· | | 1·45 | 6·15 | 19 | |
| | | 1· | | 35·8 | | | | | |
| | | 2· | | 22· | | | | | |
| | | 3· | | 22· | | | | | |
| | | 4· | | 22· | | | | | |
| | | 6· | | 44· | 196·8 | | | | |
| 5th | 8· | 0 | 6·6 | 176· | 182·6 | 2·0 | 6· | 27 | |
| 6th was incomplete in these respects. *Vide* Table II. | | | | | | | | | |
| 7th | 72· | 0 | 6·6 | 33· | | 3·45 | 6· | 19 | |
| | day | 1· | | 16·5 | | | | | |
| | | 2·15 | | 33· | | | | | |
| | | 3·30 | | 16·5 | | | | | |
| | | 5·0 | | 33· | | | | | |
| | | 5·45 | | 16·5 | | | | | |
| | | 6·30 | | 16·5 | | | | | |
| | | 8· | | 33· | 204·6 | | | | |
| | night | 12· | | 33· | | | 12· | 22 | |
| | | 16· | | 16·5 | | | | | |
| | | 20· | | 16·5 | | | | | |
| | | 21· | | 16·5 | 82·5 | | | | |
| | day | | | | 77·15 | | 12· | 17 | |
| | night | | | | 61·0 | | 12· | 13 | |
| | day | | | | 99·2 | | 12· | 7 | |
| | night | | | | 99·2 | | 12· | 11 | |

TABLE II.—STATE of OVENS and results of COOKING.

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| Number of experiment. | Time from commencement. | Temperature of ovens, degrees Fahr. | | | | Meat cooked, lbs. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | No. 1. | No. 2. | No. 3. | No. 4. | Raw. | Cooked. | Loss per cent. | — |
| | h.m. | | | | | lbs. | lbs. | lbs. | |
| 1st | ·30 | 150 | 140 | 120 | 100 | | | | |
| | 1· | 170 | 160 | 140 | 110 | | | | |
| | 1·30 | 180 | 170 | 150 | 140 | | | | |
| | 2· | 200 | 190 | 180 | 150 | | | | |
| | 2·30 | 260 | 230 | 220 | 200 | | | | |
| 2nd | 2·30 | 200 | 190 | 180 | 175 | | | | |
| 3rd | 0 | 75 | 75 | 75 | 75 | | | | |
| | 3·15 | 230 | 230 | 230 | 230 | | | | |
| | 6·45 | 330 | | 330 | | | | | |
| 4th | ·30 | 150 | 140 | 160 | 150 | 22· | 18·7 | 15· | } 3 pieces of meat roasted in oven. |
| | 3· | 300 | 320 | 330 | 300 | 18·7 | 12·1 | 35· | |
| | — | — | — | — | — | 12·1 | 8·8 | 28· | |
| 5th | 0 | 71 | 71 | 71 | 71 | 9·9 | 7·7 | 22· | Mutton steamed. |
| | 3· | 300 | 300 | 300 | 300 | 12·1 | 8·25 | 31·8 | Beef roasted in oven. |
| 6th | ·35 | 85 | 105 | 105 | 91 | — | — | — | |
| | 2·35 | 290 | 280 | 400 | 330 | — | — | — | This heat maintained for 5 hours. |
| 7th | 0 | 75 | 75 | 75 | 75 | — | — | — | } Day. |
| | 3·30 | 255 | 270 | 260 | 240 | — | — | — | |
| | 16· | 90 | 90 | 90 | 90 | — | — | — | Night. |
| | 24· | 270 | 270 | 270 | 270 | — | — | — | } Day. |
| | 25·30 | 300 | 300 | 300 | 300 | — | — | — | |
| | 44· | 90 | 90 | 90 | 90 | — | — | — | Night. |
| | 48· | 290 | 290 | 290 | 275 | — | — | — | } Day. |
| | 51·30 | 360 | 370 | 350 | 390 | — | — | — | |
| | 60· | 260 | 270 | 250 | 240 | — | — | — | } Night. |
| | 66· | 90 | 90 | 90 | 90 | — | — | — | |

It will be seen by an examination of these tables that they are not much to be depended on, except as a general guide to the capabilities of the apparatus. It is due to the maker to state that the draught of the chimney was not very good, which may account for much that does not appear consistent in the results.

Deductions from results of trials.

The following general conclusions may be deduced:—

The consumption of fuel is about 24 lbs. per hour.

The boiler is ready for steaming purposes about two hours from the time of lighting.

The ovens are ready for roasting in about one hour after lighting, and for baking in about three hours.

The per-centage of loss of weight of meat in cooking is high.

Capt. Webber on Testing House.

By a consumption of about 7 lb. of coal an hour at night the apparatus will be ready for almost immediate use in the morning, which is an advantage on board a passenger ship.

A similar apparatus is in use on board the Royal Mail Company's ship "Douro," and is said to be capable of cooking for 300 saloon passengers.

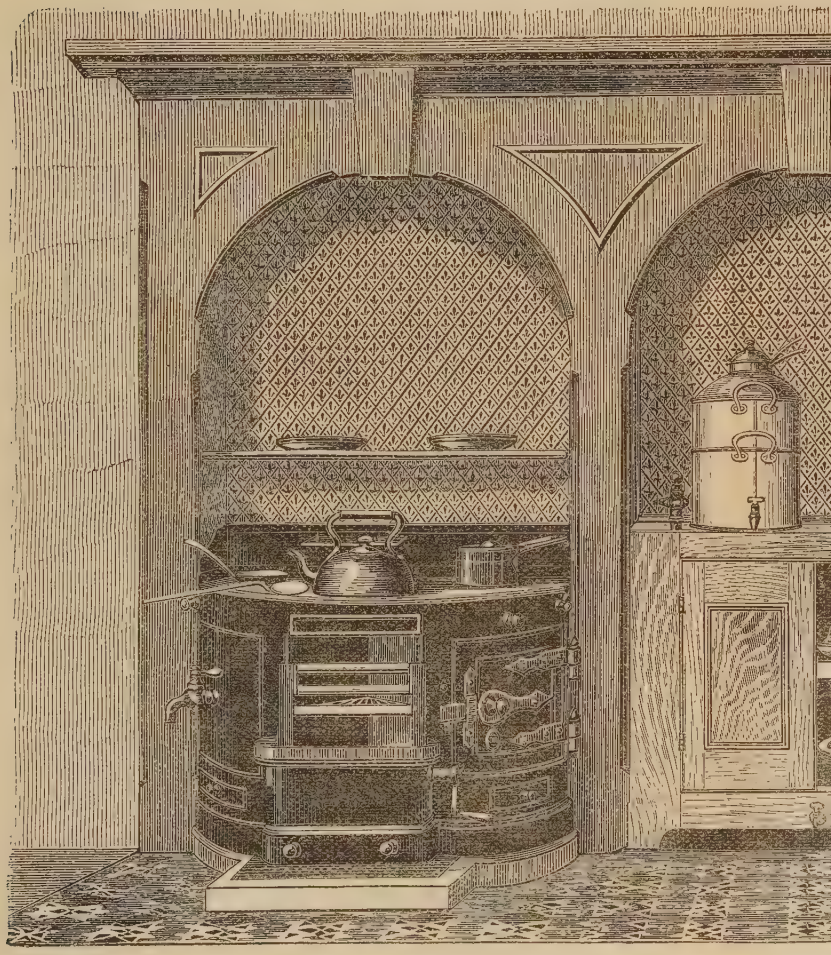
Messrs. Benham have fitted up on board H.M.'s steam transport "Crocodile" an apparatus in many ways superior to this, which covering very little more space contains 10 ovens, and boilers holding nearly 560 gallons, and is capable of cooking for 1,200 persons, with a consumption of about 650 lbs. of coal in 24 hours, or 36 lbs. an hour by day, and 18 lbs. by night.

(*See illustration on opposite page.*)

Description of the range.

In plan the range is semi-circular. The boiler and oven are rectangular, their contiguous faces being at right angles to one another, leaving a triangular space for the grate, which is diminished in size by two fire lumps on its two inner sides. The boiler projects further to the rear than the oven, and has a box opening with cover rising above the hot plate. The flame and smoke passing over both boiler and oven, descends at the further side and then passes underneath uniting in a circular smoke flue which ascends at the back of the range. The draught may be cut off at either side by a small valve when it is required to direct all the heat to one vessel. The bottom of the grate can be raised and lowered at pleasure, carrying with it the cinder sifter and tray. The movement is simply effected by a keyed winch turning a cog and wratchet. The front fire bars can be taken out or replaced as required. Underneath the hearthstone is an ashpit capable of holding a week's consumption, and from this ashpit runs a dust flue which ascends the back of the range and joins the smoke pipe, the ventilating pipe from the oven being carried into the same flue. Immediately above the level of the hot plate the smoke flue is formed of a small hollow truncated conical boiler, which is connected by means of two pipes with a cistern at any required distance from the range. The water in this boiler is partly heated by a steam pipe from the box opening of the large boiler, which passing spirally through it reaches to the supply cistern, the water in which it warms. Another steam pipe, which as well as the first, is provided with a stop-cock, communicates with the two steamers and lining of the hot closet seen in the engraving. The smoke ascends in an iron pipe 6 inches diameter placed in the chimney to a height if possible of 16 feet above the range,

*Richard's Patent Circular Cooking Range, by W. Barton,*



RICHARD'S CIRCULAR-FRONT COOKING-STOVE, IMPROVED AND MANUFACT
OF BOSTON, LINCOLNSHIRE.

and the kitchen is ventilated and smells carried off in the chimney itself, which can thus be left open over the hot plate. The boiler tap is fixed five inches above the bottom of the boiler so that all the water can never be drawn off.

Content of boiler, 17½ gallons, of which 13 are available.

Content of bath cistern, 36 gallons.

Twelve trials of various kinds were made with this apparatus; and it was lighted twice a week for the inspection of the public during the period of the Exhibition.

Three trials are recorded:—

*First.*—Temperature of air and water before lighting; 69° F. and 71° F. respectively. First trial.

The size of the grate was not altered at all during this trial, that is to say, the distance between the under surface of the hot plate and the bottom bars remained at 7½ inches.

| | | | | | |
|---|---|---|---|---|---|
| Fire lighted with wood, | | ·5 kilo. | = | 1·1024 lbs. | |
| „ „ | coal | 3 „ | = | 6·6614 „ | |
| In 20 minutes | „ | 1 „ | = | 2·2048 „ | added. |
| In 43 „ | „ | 2 „ | = | 4·4096 „ | „ |
| In 72 „ | „ | 1·2 „ | = | 4·4096 „ | „ |
| In 90 „ | „ | 0·8 „ | | | |
| In 123 „ | „ | 1 „ | = | 2·2048 „ | „ |
| In 150 „ | „ | 1 „ | = | 2·2048 „ | „ |
| In 180 „ | „ | 1 „ | = | 2·2048 „ | „ |
| Total coal | - | 11 kilo. | = | 25 lbs. | |

State of oven.

| | | |
|---|---|---|
| 35 minutes from time of lighting | - | 145° F. |
| 65 „ „ „ | - | 205° F. |
| 95 „ „ „ | - | 260° F. |

At which temperature it remained until 180 minutes.

Small vessels of various sizes placed on hot plate.

| Time after Lighting. | Containing, | Time to reach Boiling Point. |
|---|---|---|
| 30 minutes. | 28 pints. | 60 minutes. |
| 30 „ | 10·5 „ | 40 „ |
| 30 „ | 7 „ | 20 „ |
| 49 „ | 3·5 „ | 54 „ |
| 49 „ | two 1·76 „ | 77 „ |
| 49 „ | 7 „ | 82 „ |
| 52 „ | two 5·28 „ | 52 „ |

Capt. Webber on Testing House.

In all nine vessels containing together 63 pints, eight of them being on at the same time. They were kept on the plate and continued boiling until 150 minutes after time of lighting.

*Boiler.*—Water boiled in 76 minutes, when steam was turned into pipes for heating bath cistern.

| | | | | | |
|---|---|---|---|---|---|
| At 106 minutes, temperature of water in cistern | = | 88° F. |
| At 120 | „ | „ | „ | „ | = 98° F. |
| At 150 | „ | „ | „ | „ | = 114° F. |

When, steam was diverted to the cooking steamers which were ready for use in five minutes. When, steam was also turned into the enclosed lining of the hot closet, where the thermometer in five minutes rose to 100° F., and in 15 minutes to 154° F.

The above trial was made with the range under ordinary circumstances, the fire-box being at one-half its greatest attainable size, and the heat allowed to pass equally round boiler and oven.

Second trial.

*Second Trial.*

Before lighting.

| | | | |
|---|---|---|---|
| Temperature of water in boiler | - | 76° F. |
| „ „ bath cistern | - | 89° F. |
| „ air - - | - | 69° F. |

Fire lighted with wood, ·5 kilo. = 1·1024 lbs.

| | | | | | | |
|---|---|---|---|---|---|---|
| „ „ coal | 2 | „ | = | 4·4096 | „ | |
| In 20 minutes „ | 2 | „ | = | 4·4096 | „ | added. |
| In 40 „ „ | 2 | „ | = | 4·4096 | „ | „ |
| In 60 „ „ | 2 | „ | = | 4·4096 | „ | „ |
| In 80 „ „ | 2 | „ | = | 4·4096 | „ | „ |
| In 100 „ „ | 1 | „ | = | 4·4096 | „ | „ |
| In 115 „ „ | 1 | „ | | | | |
| Total coal - | 12 | „ | | 26·4576 | lbs. | „ |

State of oven.

| | | | | |
|---|---|---|---|---|
| 60 minutes from time of lighting - | - | 195° F. |
| 80 „ „ „ - | - | 275° F. |
| 115 „ „ „ - | - | 400° F. |
| 175 „ „ „ - | - | 430° F. |
| 260 „ „ „ - | - | 285° F. |
| 280 „ „ „ - | - | 230° F. |

*Boiler.*—Water boiled in 95 minutes, when steam was turned into boiler heating the bath cistern, which it raised

10° F. in 17 minutes. It was then diverted as in first trial with equal results, except that it was found that steam was being produced more quickly than necessary.

CAPT. WEBBER ON TESTING HOUSE.

At 115 min., thermo. = 90° F., placed at 1 ft. from side of range, where cook would stand.
At 115 „ „ = 125° F., 1 ft. above hot plate.
At 115 „ „ = 326° F. in meat screen.
At 145 „ „ = 285° F. „ } Fire being reduced by raising bottom bars. } Thermo. placed in coldest part of screen.
At 170 „ „ = 215° F. „
At 180 „ „ = 205° F. „
At 190 „ „ = 200° F. „
At 205 „ „ = 195° F. „
At 220 „ „ = 165° F. „

In this trial the distance between the hot plate and the bottom bars, when the fire was lighted, was 7 inches; as the fuel burned up, the bottom was lowered until at 80 minutes that distance was at its greatest, viz., 15 inches. After 115 minutes no more fuel was added. At 135 minutes, the bottom was raised, one moveable front bar being taken off. The same operation being repeated at intervals, until at 180 minutes the bottom was raised to the highest, viz., 6 inches from the hot plate, and the last moveable bar taken off. And at 240 minutes the fire was exhausted.

Deductions from second trial.

The following points may be noticed,—That the increasing the size of the fire-box raised the temperature of the oven above the highest at which it could possibly be required.

That the boiler took longer to heat, probably due to the fire being lighted with a smaller quantity of coal than in the first trial.

That when the fire was at its largest, the temperature in the meat screen was too high for roasting, although the screen was large enough to hold the heaviest possible joint.

That when the fire was being reduced, the temperature in the bottom or coldest part of the meat screen was still sufficiently high for roasting purposes.

That supposing the whole or a portion of the hot plate was not covered with cooking vessels, considerable heat was being given off from it wastefully, and in a modified degree the same might be said for the sides of the range.

That the temperature in the oven was still at 230° F. 40 minutes after the fire was exhausted.

The suggestion presents itself that by a double casing to the sides of the range including a double door to the oven, and by a double hot plate, with pot nests in the upper one, all this waste heat might be collected, and carried to a drying closet or used in some such way; and this with increase of comfort to the cook.

CAPT. WEBBER ON TESTING HOUSE.

Third trial.

### *Third Trial.*

Before lighting.
- Temperature of water in boiler - 78° F.
- „ „ bath cistern - 98° F.
- „ air - - - 70° F.

| | | | | | | |
|---|---|---|---|---|---|---|
| Fire lighted with wood, | | | ·5 | kilo. = | 1·1024 | lbs. |
| „ | „ | coal, | 2 | „ = | 4·4096 | „ |
| In 40 minutes | | „ | 2 | „ = | 4·4096 | „ added. |
| In 65 „ | | „ | 1·2 | „ } = | 4·4096 | „ „ |
| In 80 „ | | „ | ·8 | „ } | | |
| In 110 „ | | „ | 1 | „ } | | |
| In 135 „ | | „ | 1 | „ } | | |
| In 175 „ | | „ | 1 | „ } = | 13·2368 | „ „ |
| In 225 „ | | „ | 1 | „ } | | |
| In 285 „ | | „ | 1 | „ } | | |
| In 345 „ | | „ | 1 | „ } | | |
| Total coal | | - | 12 | kilo. = | 26·4656 | lbs. |

For 260 minutes, distance between hot plate and bars, 8·66 in.
During remaining time „ „ „ 7 „

The trial commenced by turning all the heat into the flue round the boiler, which boiled at 85 minutes from time of lighting.

When, the oven damper was opened and that for the boiler was half closed steam continued to be generated, which was turned into both cisterns, cooking steamers, and hot closet simultaneously. At 435 minutes the bath cistern had risen to 125° F.

State of oven :—

| | | |
|---|---|---|
| At 85 minutes | - | 155° |
| At 115 „ | - | 270° |
| At 155 „ | - | 400° |
| At 225 „ | - | 360° |
| At 285 „ | - | 350° |
| At 345 „ | - | 350° |
| At 405 „ | - | 365° |
| At 465 „ | - | 280° |

when fire was exhausted, and the water in boiler at 185° F. During the whole of this time the temperature in the roasting screen and of the hot plate was fully equal to all the requirements of roasting and boiling.

Object of third trial.

This trial was made in order to ascertain the smallest consumption of fuel with which the apparatus could be kept at full working order for ordinary household purposes.

It will be seen that the boiler was first heated, and then the oven. It should be added that the damper in the six-

inch smoke pipe was half closed at 155 minutes, where it remained for the rest of the trial. Thus during the last four hours the range was kept at full working order with a consumption of 9·38 lbs. of coal, or at the rate of 2·345 lbs. per hour. Allowing 4 lbs. of coal the first hour, and 14 hours at work, we have a consumption of 34·5 lbs. per diem, which with coals at 20*s.* a ton costs 3·7*d.* The range has ample capabilities for a family of 15 to 20 persons, but for more than the latter number a size larger than that used would be required; but if it was used for 10 persons it will be seen that it would be at a daily cost of ·37 of a penny per head for fuel.

CAPT. WEBBER ON TESTING HOUSE.

General deduction, consumption of fuel.

There is no reason to suppose that the arrangement for raising and lowering the bottom of the grate would get out of order by use. It is substantially made and very easily moved, and forms the principal feature in the economical working of this range. The triangular form of the fire-box renders its adoption easier than if it had to be rectangular.

The moveable bars.

It should be remarked that at first Mr. Barton's range smoked very much when used in the testing house, and possibly many visitors may have noticed it in that state; but in justice to the maker it must be explained, that when he visited Paris himself he remedied this defect, which there is every reason to believe could not have existed had the flue been properly constructed.

Chimney smoked.

*Cottage Cooking Stove (cités ouvriers). Baudon, Fils, Lille, France.*

See illustration in Report on Class 24, page 21.

Contains a fireplace with cast-iron sides and an oven measuring internally 13 inches × 13 inches by 10 inches. The hot plate excepted, it is of sheet iron. The oven door hinges at the lower edge, and when opened remains supported in a horizontal position. The latch handle in closing presses the oven door into the frame. There is no boiler. The flame and smoke passes round the oven, and then ascends the smoke pipe at the rear.

Description.

In a trial of two hours the following results were obtained. The fire was lighted with 1 kilo. of coal and ·2 kilo. of wood; in 10 minutes ·5 kilo. was added; every 15 minutes after ·2 kilo. was added, until 2·5 kilo. had been expended. In 20 minutes the temperature in the oven was at 365° F., and in 45 minutes 480° F.

Results of trial.

The water in a kettle containing 4 litres placed over the fire boiled in 50 minutes after lighting.

It was found that the damper in the smoke pipe effectually regulated the rate of consumption of fuel, and consequent

Capt. Webber on Testing House.

production of heat; that when the hot plate was in working order the oven became too hot; and that when the oven was kept at a temperature of 350° F. the fire was not enough to boil a kettle in a reasonable time. Consequently the operations of baking and boiling could not be well carried on together. Between the fire and the oven there was only one thickness of cast iron, which at the lowest state of the fire always retained a dull red heat. A second lining of sheet iron with a space between would have been an advantage, as the oven would not have heated so much, and the danger of tainting the inside with burnt grease avoided.

Alterations required.

Consumption of fuel.

On further trials it was found that to work the oven properly a consumption of ·2 kilo. of coal added every half hour was sufficient with the damper turned down so as to reduce the flue by about one-third.

Price.

This apparatus, which is well constructed, costs 55 francs, and would prove dear on account of its non-durability.

*Lamp Cooking Apparatus, by Messrs. Allez, Frères, Paris.*

Allez's lamp cooker.

Consists of a tin vessel of the form of an inverted truncated cone supported on a tripod stand. At the point where the cone is cut a petroleum lamp is suspended, the flame and smoke of which ascends a chimney that passes half way up the axis, where it makes its exit by several horizontal tubes. The top of the cone receives a tin pot fitted with a cover. The space between the bottom of the pot and the point where the flame strikes is filled with water, which also fills all the space around the chimney and the sides of the pot. To prevent the heat being lost the whole vessel is provided with an outside casing of tin, with a small space between. The water is poured in at the top (the pot being removed) until it rises, so that when the pot is replaced it will be half immersed. There is a tap on the outside at the bottom of the vessel for drawing off the water when necessary.

Trial.

The result of several trials was as follows:—The water in the vessel boiled in 42 minutes after the lamp was lighted, when the water in the pot attained a temperature of about 160° F. In about 10 minutes the water in the pot increased to 208° F., which was the highest temperature it attained.

The consumption of oil was 32·5 grammes per hour.

Result.

Beef stewed in this vessel was cooked in the following time:—

| | | | | | | | Cost. | |
|---|---|---|---|---|---|---|---|---|
| Piece weighing | 1 | kilo. | in 1 | hour | 20 | minutes, | ·34 | of a penny. |
| „ | „ | 2 | „ | in 1 | „ 32 | „ | ·38 | „ |
| „ | „ | 4 | „ | in 1 | „ 57 | „ | ·47 | „ |

Loss from the beef to the water averaged about 26 per cent.

Capt. Webber on Testing House.

The cost of this apparatus is 24 francs. Petroleum costing 2*s.* 6*d.* per gallon.

The above result compares unfavourably with the use of gas in the same way, being about one-third dearer; but where that fuel was unobtainable a lamp apparatus might be used advantageously where cooking at a temperature below the boiling point, and during a long period, had to be carried on.

*Gas Cooking Stove, T. Phillips, 55, Skinner Street, London.*

This apparatus consists of a cylindrical (sheet iron) case standing on one end, and being about 30 inches high. In one side is a door, which when opened displays a shelf at a distance of about eight inches from the top, dividing the interior in two, the upper part being for baking, the lower for roasting. In the latter the meat hangs by a hook in the centre, and the whole is heated by a ring of burners round the bottom, a tray standing in the middle to receive the gravy. On the top of the apparatus is a concentric ring burner, over which a large vessel can be boiled, and under which meat can be fryed; and at one side of it are two burners for boiling smaller vessels. The apparatus is provided with a main and branches to each of the several parts, and all necessary stop cocks. It was connected with a standard metre by means of gutta percha tubing.

Cooking by gas.

Description of apparatus.

The price of this size of the apparatus (one of the smallest) is about 3*l.*

The trial took place thus. Roasting, baking, frying, boiling, and stewing were commenced simultaneously.

Description of trial.

*Roasting.*—3·75 lbs. of lean mutton were cooked in 78 minutes with a loss of 20 per cent. in weight, the greater part of which was recovered in the dripping. The proper temperature was obtained by diminishing the gas jets to about half an inch in length. The meat was well and thoroughly cooked.

*Baking.*—A small pie was placed in the top shelf, which, owing to the small amount of gas that could be consumed while roasting, was not half done in the first 78 minutes. At that time the gas was turned fully on, and the pie was sufficiently baked 120 minutes from time of lighting.

*Frying.*—Chops weighing together 1·05 lb. were cooked under the ring of gas jets in 23 minutes; and were then replaced by a steak ·6 lb., which was cooked in 14 minutes, with a loss in weight of 18½ per cent. in weight. A single chop was also cooked in 13 minutes.

Capt. Webber on Testing House.

*Boiling.*—Three vessels containing 7, $3\frac{1}{2}$, and $3\frac{1}{2}$ pints were placed together on the burners, and were respectively raised to the boiling point in 33, 35, and 35 minutes. These were then kept at a high temperature or were replaced by other vessels containing cold water during the remainder of the trial, as if engaged in the operation of boiling vegetables, stewing, &c.

The trial lasted 120 minutes; altogether there were roasted and fried, 5 lbs. meat; baked, one pie; boiled, 6 lbs. vegetables; capable of being stewed or made into soup, about $1\frac{1}{2}$ lbs. meat.

Consumption of gas.

It may be estimated, that here was supplied a plain dinner for four persons, as the meat roasted, was without bone. The consumption of gas was 62·5 cubic feet, which at 4*s.* a thousand would cost 3*d.*, or $\frac{3}{4}$*d.* for each person.

Alterations required.

Improvements might be made in this apparatus which would allow more work to be done with it, with a smaller increased consumption in proportion. The most important is the reversing of the positions of the baking and roasting places, by which the oven would be in the warmest place, and the roasting might be carried on with the full consumption of gas. Heat might be saved by having a double casing, the inner one being formed of fire-clay, and the products of combustion having been allowed to ascend might make their exit by descending between the two linings, and thus escape, after having communicated as much heat as possible to the contents.

The supply pipe for the gas is larger than necessary, which would cause waste in careless hands.

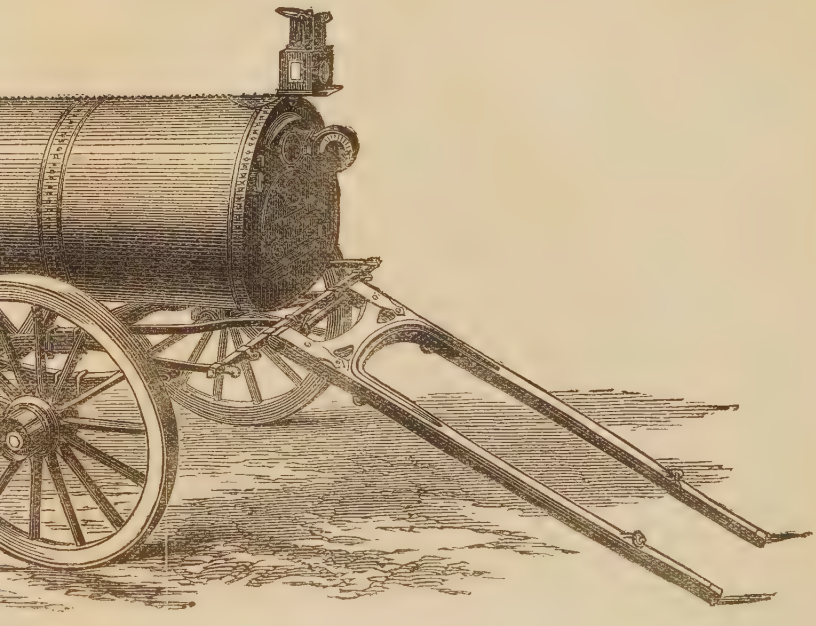
No bad effects on the meat, from being roasted in contact with the products of combustion of coal gas, could be detected by tasting.

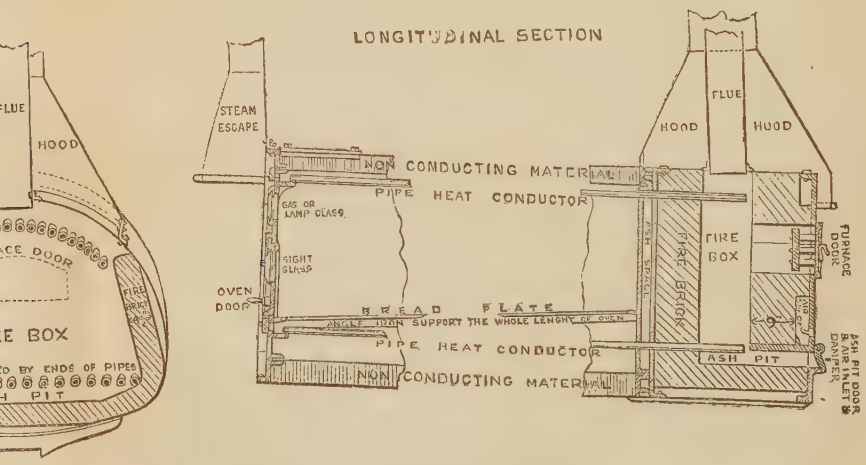
Mutton chops cooked by coal fire and by gas.

Two chops of exactly similar weight and form, and from the same joint, were fried, the one by gas in Mr. Phillips's apparatus, the other on a red fire in the ordinary way.

That by the gas was cooked in 13 minutes, with a loss of weight of 27·7 per cent. That on the coal fire in 7 minutes, with a loss of 20 per cent. The former was cooked uniformly through, and showed no marks of the fire on the surface, the latter was cooked on the surface, but not thoroughly inside. In this case the former was not exposed to the fumes of the gas, while the latter was placed exactly over a glowing coal fire; which may account for its being pronounced, by some who tasted it, superior in flavour. It is evident that the greater loss was due to the difference of time.

vens.—*Loftus Perkins*, 6, *Seaford Street, London.*






ORTABLE STEAM OVEN, HEATED BY INTERNAL HOT WATER TUBES.

Capt. Webber on Testing House.

Gas cooking stoves.

The experiments with "gas stoves" given further on, in the results compiled by Mr. Rowden, are intimately connected with the subject of cooking by gas, and the results show the application of atmospheric burners equally for this purpose. But these few trials at the Testing House leave much to be desired, amongst which the most important points for future investigation are as follows.

Points for further inquiry.

The per-centage of air necessary in an atmospheric burner to give the highest temperature of combustion, and in consequence the least radiation?

Where, in cooking, radiant heat from the combustion of gas would be more useful, and in what degree?

The effect produced on food by exposing it to the action of the products of combustion of the constituents of coal gas when burnt with a luminous or non-luminous flame?

To which may be added the investigation of the temperatures for cooking different kinds of food, an inquiry best carried on with gas as a fuel.

(*See illustration on opposite page.*)

Description.

The essential peculiarity of this invention, is the use in it of the pipes for conducting heat from the fire to the oven. It will be seen (*vide* cut) that these pipes lie longitudinally in the apparatus, their ends protruding into the fire-box. They are made of wrought iron, and hermetically sealed at both ends, having been previously one tenth filled with water. When in use the oven rests on its bearings, so that the fire-box end is the lowest, causing the water to fall to the same end. Fuel of almost any kind will in a short time convert the water in the pipes into steam, at a sufficiently high pressure, to heat the oven up to the fullest requirements for bread baking purposes.

The apparatus is very strongly constructed, and is furnished with a pyrometer in the oven door. The hood round the flue, forms a boiler, in which water is warmed nearly to the boiling point, an arrangement which would furnish sufficient hot water for the use of the sick, or for any special purpose, during a campaign.

The length of the apparatus is 10 ft. 8 in., depth 2 ft. 8 in., width 3 ft. 5 in., weight of the largest size, without carriage, 1 ton 6 cwt., with carriage, 2 tons. It is reported to be capable of baking 90, 4-lb. loaves every two hours. The price is 300*l.*, and a smaller size, capable of baking 48, 4-lb. loaves, cost 250*l.*

Opinion of the Commissariat Department.

So favourable is the report on this oven by the army commissariat officers, that its adoption is recommended in all the bakeries worked by their department.

CAPT. WEBBER ON TESTING HOUSE.

In the Champ de Mars, several trials took place with it in the presence of officers deputed by the Emperor of the French, and also of officers of other Governments.

Trial by jury.

On the 22nd May, the jury of Class 50 tested the powers of the oven, the dough for that purpose having been made at one of the French bakeries in the Champ de Mars. Serjeant Major Laverty was present and reports as follows:—

Fuel.—Wood 2·2 lbs. - - -
Coal 33 lbs. - - -
and nine heads of dried maizine -
} at lighting.
Coals 33 lbs. - 5·20 hours after lighting.

Total coals 66 lbs., wood 2·2 lbs., and nine maize heads.

The temperature attained in the oven, was as follows:—

| Time after lighting, in hours and minutes. | Temperature in degrees Fahr. |
|---|---|
| ·0 | 71 |
| ·40 | 150 |
| ·55 | 200 |
| 1·10 | 250 |
| 1·20 | 300 |
| 1·35 | 350 |
| 1·55 | 400 |
| 2·10 | 450 |
| 2·20 | 470 |

When the fire was damped and all draught stopped, the temperature of 470° F. was maintained for a further period of 3·40 hours.

Apparently the jury only aimed at the *quality* of the baking, as it did not occupy the whole time, or fill the oven completely.

These batches of bread were baked, two of ordinary bread respectively weighing 100 and 40 lbs., occupying an average of 36 minutes in baking; and one of short bread consisting of 140 small rolls, which took 20 minutes to bake.

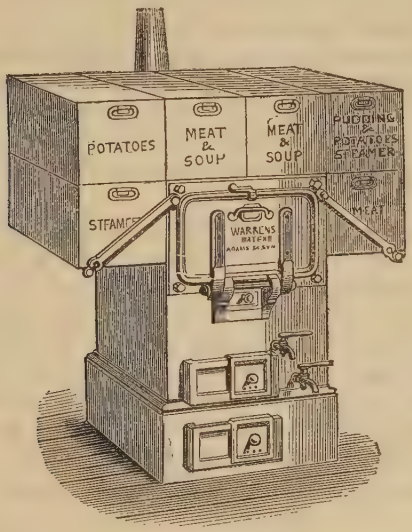
The opinion of the jury on the result was highly satisfactory.

During the Exhibition, this apparatus was continually used by one of the refreshment contractors for baking meat, which it performed very effectually.

As a general result it may be stated that the saving in fuel effected by the adaption of this invention to a baker's oven will be about three-fourths.

It might be used in cooking ranges to give a bottom heat to ovens, simplifying the apparatus by having the heat conducted round the boiler alone. Or a drying closet might be warmed in this way, by pipes under its floor protruding into the fire-clay backing of a kitchen range or other fire.

*Captain Warren's Cooking Apparatus, made and exhibited by Messrs. Adams and Sons, Marshall Street, London.*




CAPTAIN WARREN'S PATENT COOKING APPARATUS, THE ARMY AND NAVY.

This cooking apparatus, which claims perfect novelty of invention, occupies a space of 2 ft. 2 in. by 1 ft. 10 in., and is 3 ft. 7 in. high, exclusive of the six tin cooking boxes. The slide doors belong to the fire-box, the upper for feeding, the lower for ashes. There are two boilers and an oven. The former are placed one above the other, so that the lower is exposed to the direct action of the fire, and the upper, which takes a little longer to rise to the boiling point, forms the back to the oven. These boilers are so constructed that the heat passes through flues in them, and they are provided with feed pipes at the back, and whistles to announce a deficiency of water. They hold eight gallons each. The tin cookers are of two kinds, one into which the steam is directly admitted, the other having an interior lining, so that the steam enters the outer space only. There are three of each.

Capt. Webber on Testing House.

The latter kind are so arranged that the outer casing exists in the top as well as the sides. The steam communications are all simple and well fitted. Thus meat, soup, &c. can be cooked in dry air with a great diminution in the loss. The oven is large enough to roast a joint of about 23 lbs., or bake 16 lbs. of bread. Its means of ventilation is very complete. There are "draw-off" taps to both boilers, and the most efficient means for cleansing the flues.

Captain Warren claims for this invention that any viands can be cooked without coming into contact either with water, steam or fire, resulting in no loss of the nutritious portions. Besides this, that no water is absorbed by the meat, which is cooked at a temperature most favourable for the purpose. That one set of vessels can be used for either baking or boiling. And that dressed meat can be kept hot for some time without being spoilt.

Very complete trials of this apparatus had taken place previous to the Paris Exhibition of 1867, both at Portsmouth and Aldershot, resulting in a unanimous approval of it on the part of the authorities and the soldiers, on the ground of its extreme economy of fuel, the simplicity of its management, and the efficient way in which it cooked the soldiers' rations. The general result of some of these trials showed that it could be kept at work with a consumption of about 1 lb. of wood and 22½ lbs. coal per diem.

Cooking for 16 men 7 oz. per man per diem.
„ 71 „ 5 „ „ „
„ 100 „ 4 „ „ „

and giving an amply supply of hot water for scullery purposes. A very complete set of instructions for the guidance of soldiers using this apparatus have been drawn up by Serjeant-major Laverty, whose duty it is to give practical teaching in cooking at the instructional kitchen at Aldershot.

The following table is constructed from the results of 19 trials by Serjeant-major Laverty in the Testing House. The temperatures of the oven were maintained at the height of the last registration in each case, to nearly the close of the trial.

The apparatus was constantly at work during the whole period of the Exhibition, and never was out of order or showed the least sign of deterioration. A very large amount of meat was cooked in it for the refreshment contractor, but the writer does not consider the register of the results of a sufficiently instructive nature to publish them.

TABLE showing Results of Trials at Paris.

| Number of Experiment. | Length of Experiment in Hours. | Fuel supplied. | | | | Time after lighting at which Water boiled in boilers. | Time allowed to boil. | Total Evaporation. | Time from Commencement. | Temperature of Oven, Degrees Fahr. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Time from Commencement of Experiment. | Wood. | Coal. | Total Fuel. | | | | | | |
| | H.M. | H. M. | lb. | lb. | lbs. | H. M. | H. M. | Gal. | H. M. | | |
| 1st - | 5 15 | 0 | 1·1 | 6·6 | — | 0 30 | 4 45 | 5 | 0 | 69 | Temperature of water before lighting, 65° F. |
| | | 1 15 | — | 2·2 | — | — | — | — | 0 45 | 108 | |
| | | 1 45 | — | 2·2 | — | — | — | — | 1 45 | 200 | |
| | | 2 15 | — | 2·2 | — | — | — | — | 2 15 | 240 | |
| | | 2 45 | — | 2·2 | 16·5 | — | — | — | 0 30 | 110 | |
| 2nd - | 5 30 | 0 | 1·1 | 6·6 | — | 0 30 | 5 | 5 | 1 0 | 200 | |
| | | 1 15 | — | 2·2 | — | — | — | — | 1 30 | 250 | |
| | | 1 45 | — | 2·2 | — | — | — | — | 2 0 | 300 | |
| | | 2 15 | — | 2·2 | — | — | — | — | 2 30 | 370 | |
| | | 3 15 | — | 4·4 | 18·7 | — | — | — | — | — | |
| 3rd - | 9 30 | 0 | 1·1 | 6·6 | — | 0 30 | 9 0 | 8 | 0 | 71 | |
| | | 1 30 | — | 2·2 | — | — | — | — | 0 30 | 320 | |
| | | 2 30 | — | 2·2 | — | — | — | — | 1 0 | 400 | |
| | | 3 0 | — | 2·2 | — | — | — | — | — | — | |
| | | 4 0 | — | 2·2 | — | — | — | — | — | — | |
| | | 6 0 | — | 2·2 | 18·7 | — | — | — | — | — | |
| 4th - | 10 0 | 0 | 1·1 | 6·6 | — | 0 30 | 9 30 | 7 | 0 | 71 | |
| | | 1 0 | — | 2·2 | — | — | — | — | 0 30 | 320 | |
| | | 1 45 | — | 2·2 | — | — | — | — | 1 0 | 400 | |
| | | 4 0 | — | 2·2 | — | — | — | — | — | — | |
| | | 7 0 | — | 2·2 | 15·5 | — | — | — | — | — | |
| 5th - | 7 20 | 0 | 1·1 | 4·4 | — | 0 20 | 7 0 | 7½ | 0 | 68 | |
| | | 2 04 | — | 3·3 | — | — | — | — | 0 30 | 435 | |
| | | 4 40 | — | 3·3 | — | — | — | — | — | — | |
| | | 6 10 | — | 3·3 | 15·4 | — | — | — | — | — | |

From continual observation of Captain Warren's apparatus and the facts shown above, the writer feels convinced that the War Department has exercised the wisest economy, with a great advantage to the soldier in the cooking of his food, in selecting it for general use in the army. To the soldier abroad who may have to take his duty as cook in hot weather it is an inestimable boon, saving him from exposure to excessive heat.

The writer heartily joins with the inventor in recommending its use in prisons, hospitals, workhouses, co-operative dining rooms, and places where about 100 persons have daily to be supplied with three meals. In most cases such establishments possess cooking ranges, which at the lowest calculation consume 1 lb. of coal per head a day, with none of the conveniences possessed by this. Its price, 45*l.*, is not excessive, and would be soon neutralized by the economy of fuel, and in places where the number of inmates fluctuated, one or more others might be kept in reserve.

CAPT. WEBBER ON TESTING HOUSE.

*Kitchen Ranges and Portable Cooking Stove.—Messrs. Brown and Green, of Luton, England.*

The range.

The kitchen range is an improved form of the ordinary close range, well constructed and very compact, but not presenting any prominent features to distinguish it as an invention. It is rather a specimen of what the manufacturer considers to be the best form of kitchener on established principles.

The cooking stove.

The portable cooking stove is the only specimen of this kind of apparatus, so well known in France, Belgium, and America, by an English exhibitor. It cannot be said to be an imitation, as it has distinctive features, although there is nothing new in the principle. Accompanying the report on Class 24 there is a sketch and description of this object (*vide* page 21).

TABLE showing the Results of some of the Trials made with the Kitchener.

| Number of Experiment. | Length of Experiment. | Fuel. Wood. | Fuel. Coal. | Fuel. Total Fuel. | Time from Commencement. | Temperature of Oven. | Time after lighting Water boiled in Boiler. | Time allowed to boil. | Evaporation. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | H. M. | lbs. | lbs. | lbs. | H. M. | Deg. F. | H. M. | H. M. | Gals. | |
| 1st - | 6 30 | 2·2 | 15·4 | — | 0 | 72 | 1 30 | 5 0 | 4·5 | |
| | | | — | — | 1 0 | 90 | — | — | — | |
| | | | — | — | 2 0 | 120 | — | — | — | |
| | | | 7·7 | — | 2 30 | — | — | — | — | |
| | | | 7·7 | — | 2 45 | — | — | — | — | |
| | | | 9·9 | — | 3 0 | 250 | — | — | — | |
| | | | 9·9 | — | 3 30 | 300 | — | — | — | |
| | | | 11·0 | 63·8 | 4 0 | 300 | — | — | — | |
| 2nd - | 8 0 | 1·1 | 6·6 | — | 0 | 75 | 1 30 | 6 30 | 2·5 | Only 4 gallons of water in the boiler at the commencement. |
| | | | — | — | 1 0 | 112 | — | — | — | |
| | | | 13·2 | — | 2 0 | 208 | — | — | — | |
| | | | 7·7 | — | 3 0 | 300 | — | — | — | |
| | | | 13·2 | — | 5 0 | 300 | — | — | — | |
| | | | 7·7 | — | 6 0 | 300 | — | — | — | |
| | | | 7·7 | 57·2 | 7 0 | 300 | — | — | — | |
| 3rd - | 7 0 | 2·2 | 15·4 | — | 0 | 75 | 1 30 | 5 30 | 4·5 | 7 gallons of water in boiler at commencement. |
| | | | — | — | 1 0 | 120 | — | — | — | |
| | | | 7·7 | — | 2 0 | 200 | — | — | — | |
| | | | — | — | 3 0 | 300 | — | — | — | |
| | | | 9·9 | — | 3 30 | 300 | — | — | — | |
| | | | 12·1 | — | 5 0 | 300 | — | — | — | |
| | | | 7·7 | 55·0 | 5 30 | 300 | — | — | — | |

Result with kitchener.

An inspection of these results will at once show that the consumption of coal is very great, proving how easy it is to construct a range which, although producing a favourable impression at sight, is found out on trial to be a very wasteful consumer of fuel, and in this case without good results in the temperature of the oven. A considerable amount of cooking was carried on for the inspection of visitors with this

range, but the results are not recorded in such a way as to give trustworthy evidence. The hot plate always worked well, in fact being generally over-heated, and the fire-place is well adapted for roasting in the ordinary way with a screen and jack.



Table showing the Results of some of the Trials with the Portable Stove.

| Number of Experiment. | Length of Experiment. | Fuel. | | | Time from Commencement. | Temperature of Oven. | Time after lighting Water boiled in Boiler. | Time allowed to boil. | Evaporation. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Wood. | Coal. | Total Fuel. | | | | | | |
| | H. M. | lbs. | lbs. | lbs. | H. M. | Deg. F. | H. M. | H. M. | Gals. | |
| 1st - | 6 0 | 1·1 | 11·1 | — | 0 | 75 | 1 0 | 5 0 | 2·5 | 2·5 gallons in boiler at commencement |
| | | | — | — | 0 30 | 200 | — | — | — | |
| | | | 4·4 | — | 1 0 | 300 | — | — | — | |
| | | | 7·7 | — | 4 0 | 300 | — | — | — | |
| | | | 5·5 | 29·8 | 5 0 | 300 | — | — | — | |
| 2nd - | — | 1·1 | 5·5 | — | 0 | 69 | 2·45 | 2·30 | 2· | Do. |
| | | | — | — | 0 45 | 190 | — | — | — | |
| | | | 3·3 | — | 1 15 | 270 | — | — | — | |
| | | | — | — | 1 45 | 300 | — | — | — | |
| | | | 3·3 | — | 2 15 | 300 | — | — | — | |
| | | | 3·3 | — | 3 15 | 300 | — | — | — | |
| | | | 3·3 | 19·8 | 4 15 | 300 | — | — | — | |
| 3rd - | 5 35 | 2·2 | 8·8 | — | 0 | 70 | 0 50 | 4 45 | ·875 | Contained 1·75 gallons at commencement. |
| | | | — | — | 0 35 | 190 | — | — | — | |
| | | | — | — | 1 5 | 300 | — | — | — | |
| | | | — | — | 1 35 | 510 | — | — | — | |
| | | | 4·4 | — | 2 5 | 510 | — | — | — | |
| | | | 4·4 | 17·6 | 3 5 | 510 | — | — | — | |

Results with portable stove.

It may be estimated from the above results that 3 lbs. of coal per hour would keep this little apparatus entirely at work, and that when not in use a consumption of 2 lbs. per hour would be sufficient; or a total of 30 lbs. per diem, costing 3·9*d.*, coal being 25*s.* per ton.

Vessels containing 4·4 pints and 2½ gallons boiled on the hot plate in 30 and 60 minutes respectively.

The temperature in the hottest part of the roasting screen was maintained at 260° F., and in the coldest at 210° F. The screen is capable of roasting a joint of about 8 lbs.

A plain dinner, consisting of soup, roast meat, two vegetables, and a pudding, sufficient for eight persons, might be very efficiently cooked with this stove.

To work the oven and hot plate there is a wasteful consumption of fuel, which would be remedied by having the fire-box door at the end, the boiler behind and on each side the oven beyond, and the heat passing under and up the far side of the oven before escaping. At the same time the diameter of the smoke pipe might be reduced to three inches, as in the French stoves.

CAPT. WEBBER ON TESTING HOUSE.

*Soyer's Portable Field Cooking Apparatus, made and exhibited by Messrs. Radcliffe, Leamington.*

Description. This was brought out by Mons. Soyer at the close of the Crimean war, as a simple means of boiling the food of soldiers while in the field. It consists of a large iron cylinder, having an interior lining around the fire-box, measuring 3 feet 6 in inches length, and 2 feet 4 inches in diameter, which stands on one end, the lower part holding a fire-box with a fire-door opening externally, above which is suspended a large boiler which almost fills the interior, holds nine gallons, and has its own cover. The top of the cylinder has also a moveable cover, which, when closed, obliges the smoke from the fire to pass up a smoke pipe which is attached to the side, and the cowl of which is about 7 feet from the ground. The ashes from the fire fall out through a grating in the bottom of the cylinder, which is raised a few inches above the ground by iron feet.

Fuel. The apparatus was repeatedly tried and weekly exhibited in action during the Exhibition. It stood in the open air in the garden surrounding the Testing House.

| | |
|---|---|
| When lighted it was charged with 3·3 lbs. wood and | 12 lbs. of coal |
| In 30 minutes from time of lighting | 7·7 lbs. of coal added |
| In 2 hours 45 minutes „ „ | 5·5 lbs. „ |
| Total consumption of coal | 25·2 lbs. „ „ |
| Total consumption of wood | 3·3 |
| Total fuel | 28·5 lbs. |

Boiler. The water in the boiler boiled in 30 minutes from the time of lighting. It was allowed to boil, the draught being reduced in the flue, for 5 hours 15 minutes, when 4 gallons were evaporated.

Result. The general results of this simple appliance is good, and if there was any means of reducing the size of the fire-box for coal, and a key damper fixed in the flue, the results would show a much smaller consumption.

If used to stew meat for soldiers in camp it is capable of cooking for 100 men. It weighs from 2 to 3 cwt.

The principle is good. It is nothing more than confining the heat of a fire so as to make the pot boil with a small consumption of fuel in contrast to the gipsy fire with a pot suspended over it from a tripod.

Alterations necessary. The improvements necessary are as follows:—Retaining the size of the pot, a form of outside casing that in weight

would balance the former as a load for a pack animal. The flue and fire-box being carried between. A simple form of moveable fire-box for coal or charcoal, allowing of a larger space below the pot for the fire when wood was used. The outside of casing and flue to be galvanized.

*Close Fire Range.—General Iron Foundry Company, Thames Street, London.*

Trials not of a nature to be recorded.

This Company exhibited a small close fire cooking range, fixed for trial in the cooking room of the Testing House. It was tried repeatedly by Serjeant-Major Lavertry, but without results such as to warrant their being received as an evidence of its capabilities.

It is to be believed that under more favourable circumstances of draught the performance would be of such a nature as to do credit to its manufacturers. As a close range the form is good and the fire-box not too large. The printed "Directions for setting ranges" issued by this Firm, deserve notice.

*Cottager's Grate.—Mr. Sparkes Hall, Regent Street, London.*

Description.

This gentleman (who is also an exhibitor in another class) fixed in the large room of the Testing House a specimen of this grate, which was made by a village blacksmith, and consists of an ordinary grate with an oven at one side, so placed that the bottom and top of the oven are both about three or four inches above the lower and upper bars of the fire-place, allowing when set of the heat from the lower part of the fire to pass under, and up, the far side of the oven. The fire-place is large and capable of burning small pieces of wood.

Result of trial.

When tried with coal on several occasions, the oven could not be heated above 150° F., a temperature far too low for most cooking purposes, but this defect might be easily remedied by any simple means of producing a draught through the flue round the oven, which does not now exist.

Consumption of fuel.

It is difficult to estimate the consumption of fuel necessary in an open grate to be used in the room of a cottage because so much depends on the requirements of the family and temperature. But as used in the Testing House 3 lbs. per hour of Newcastle coal is not too high, and even then, as the grate is constructed, the oven is no better than a hot closet, and there is only room to boil one large pot.

Capt. Webber on Testing House.

Mr. Sparkes Hall has given this grate to several cottagers in some country district in England, and in doing so has doubtless benefited them by adding an oven, where perhaps none formerly existed; but it cannot be said that an advance in economy has been made by it.

### *Small Cooking Stove by Messrs. Barbezat and Co., of Paris.*

This stove is similar to one by M. Godin Lemaire, of which an illustration is given in the report on Class 24, preceding this. And the reader is referred to the same place for further information on the subject of cooking stoves of this description, adapted for the use of small dwellings.

Table of Results of Two of the Trials with M. Barbezat's Stove.

| Number of Experiment. | Length of Experiment. | Fuel. Wood. | Fuel. Coal. | Fuel. Total Fuel. | Time from Commencement. | Temperature of Oven. | Time after lighting Water boiled in Boiler. | Time allowed to boil. | Evaporation. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | H. M. | lbs. | lbs. | lbs. | H. M. | Deg. F. | H. M. | H. M. | Gals. | |
| 1st - | 8 15 | 1·1 | 9·9 | — | 0 | 77 | 0 30 | 7 45 | 2·5 | Boiler contained 2·5 gallons at lighting. |
| | | | — | — | 0 15 | 120 | — | — | — | |
| | | | — | — | 0 45 | 270 | — | — | — | |
| | | | 4·4 | — | 1 15 | 300 | — | — | — | |
| | | | 2·2 | — | 2 15 | 420 | — | — | — | |
| | | | 3·3 | — | 3 15 | 420 | — | — | — | |
| | | | — | — | 4 15 | 312 | — | — | — | |
| | | | 3·3 | 24·2 | 6 15 | — | — | — | — | |
| 2nd - | 7 30 | 1·1 | 7·7 | — | 0 | 75 | 0 30 | 7 0 | 2·5 | Do. |
| | | | — | — | 1 0 | 300 | — | — | — | |
| | | | — | — | 1 30 | 320 | — | — | — | |
| | | | 4·4 | — | 2 30 | 320 | — | — | — | |
| | | | 4·4 | — | 4 30 | 320 | — | — | — | |
| | | | 4·4 | 22·0 | 6 0 | 320 | — | — | — | |

Result

It will be seen that the result of the last trial is very good, both as regards the state of the oven and boiler. During the same time the hot plate was in efficient working order for either boiling or stewing. It will be seen that a consumption of 2·2 lbs. per hour is sufficient to keep the stove in active work; the same amount every two hours would be enough when not used for cooking. Allowing four hours of active work and 10 of slow combustion, gives a daily consumption of 19·9 lbs. or 2·66 pence with coal at 25*s.* a ton. The table also shows that the boiler ought to be refilled once during the day.

Used by English sailors on barge.

This apparatus, which cost 65 francs, was used for cooking their food by the sailors of the Royal Navy, on board the barge in the Seine, and met with their unanimous approval.

### *Small Cooking Stove by M. Boutier, of Lyons.*

CAPT. WEBBER ON TESTING HOUSE.

An illustration of this stove, with description, is given in the report on Class 24.

TABLE of Results of Two of the Trials wade with M. Boutier's Stove.

| Number of Experiment. | Length of Experiment. | Fuel. Wood. | Fuel. Coal. | Fuel. Total Fuel. | Time from Commencement. | Temperature of Oven. | Time after lighting Water boiled in Boiler. | Time allowed to boil. | Evaporation. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | H. M. | lbs. | lbs. | lbs. | H. M. | Deg. F. | H. M. | H. M. | Pints. | |
| 1st - | 5 50 | 2·2 | 4·4 | — | 0 | * | 0 50 | 5 0 | 10½ | Water in |
| | | | — | — | 0 15 | 145 | — | — | — | boiler at |
| | | | — | — | 0 5[illegible] | 331 | — | — | — | commence- |
| | | | 2·2 | — | 1 10 | — | — | — | — | ment 10½ |
| | | | 4·4 | — | 3 30 | — | — | — | — | pints. |
| | | | 4·4 | 17·6 | 4 50 | — | — | — | — | |
| 2nd - | 5 35 | 2·2 | 4·4 | — | 0 | * | 0 35 | 3 15 | 7 | 2nd experi- |
| | when | | — | — | 0 15 | 158 | — | — | — | ment, wa- |
| | fire was | | — | — | 0 30 | 320 | — | — | — | ter in boiler |
| | ex- | | 2·2 | — | 0 45 | — | — | — | — | 7 pints. |
| | hausted | | 2·2 | 11·0 | 3 45 | — | — | — | — | |

* Not recorded, but probably about 70°.

A vessel containing 3½ gallons was placed immediately over the fire, at five minutes, and boiled at 1h. 20m., after lighting.

After 30 mins. from lighting the oven became too hot.

Tendency of ovens to become overheated.

At 1 h. 20 m. ,, the damper was closed so as to cut off three-fourths of flue.

At 1 h. 25 m. ,, water in boiler ceased to boil.

At 1 h. 35 m. ,, damper opened to cut off half flue.

At 1 h. 45 m. ,, water again began to boil.

During the above changes the temperature of the oven continued at above 350° F.

This trial shows the tendency of stoves of this description to over heat the oven when the hot plate and boiler are in working order. And it is worthy of remark that with a smaller consumption of fuel than in Barbezat's stove greater heat was developed. It is estimated that the cost of fuel for a day of 14 hours in this apparatus would be about 2½*d.*

Cooking stoves not tested for warming.

It is greatly to be regretted that one of these portable cooking stoves was not placed in the chamber for testing warming stoves (described further on in this report) for the

Capt. Webber on Testing House.

purpose of ascertaining the amount of heat radiated from it externally while at work. Although some little information may be gleaned from the recorded trials, the writer feels bound to confess that an analyzation shows much to be desired.

*Small Cooking Grate for Married Soldiers, made by Messrs. Benham and Son, Wigmore Street, London, exhibited by the Secretary of State for War.*

This grate is fully illustrated in the report on Class 24, where the adoption of Captain Galton's plan for warming and ventilating the room in which it is placed, is shown.

Description.

The grate contains no boiler, and is set so that the oven is isolated from the brickwork at the back and side, the intervening space having no communication with the external air, thus securing a retention of heat in the oven, which receives it only from the side touching the fire.

## Section II.

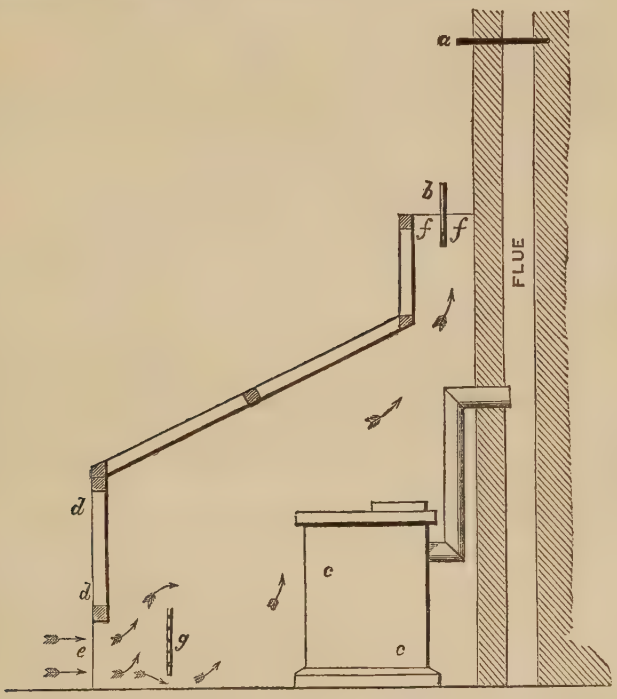


### Account of Experiments made with Stoves, Gas Apparatus, Lamps, &c. by Captain Webber, R.E., and Mr. W. T. Rowden.—Compiled by Mr. W. T. Rowden.

#### Experiments on Stoves for Heating Apartments, Buildings, &c.

Description of chamber for testing stoves.

The chamber in which the stoves were placed for these experiments is shown in section in the annexed figure. It




CHAMBER FOR TESTING THE HEATING POWER OF STOVES.

*a*. Damper. *b*. Thermometers. *c, c*. Stove. *d, d*. Moveable front of chamber. *e*. Inlet for air. *f, f*. Outlet for heated air. *g*. Screen to prevent radiation through opening *e*.

was formed of a framework of wood lined both internally and externally with sheet zinc. The linings were made air-tight and enclosed between them a layer of air about 3 inches thick. The front was made moveable for the purpose of arranging and charging the stoves.

Capt. Webbe and Mr. Rowden on Testing House.

The wall containing the flue formed the back of the chamber, the top of which tapered from each of the three sides to an opening 2 feet by 1 foot, and from this opening the sides again ran vertically for 1 foot 6 inches.

After many hours' experiment with a stove the exterior coating of the chamber remained quite cool.

Mode of testing stoves.

A stove having been fixed in its proper position on the previous day a fire was lighted early in the morning and afterwards charged regularly every half-hour with a weighed quantity of fuel. After the fire had burned uniformly for some hours, and the temperature, as indicated by three thermometers suspended at the outlet, had become pretty constant, the velocity of the air at the outlet was taken at intervals of five minutes by a small anemometer. These observations were made in six positions, the instrument having run for three minutes in each.

A register of the thermometers was made after each observation. These six experiments thus occupied half an hour. The stove was then allowed to continue burning (being charged at proper intervals) for an hour, when another series of six observations was made, and so on. The stoves were, on an average, thus tested during six hours after the fire had become constant, and on two or three days. The figures in the table are the averages of all the observations made.

Manner of testing M. Jolly's stove.

With the stove of Mons. Jolly the mode of procedure was necessarily somewhat modified as the fire is lighted at the top and cannot be recharged till entirely burned out. This stove was lighted in the morning and observations made every alternate half-hour during the whole of the time it was burning.

Table of results.

Table of the Results of Experiments on Stoves.

| Name of Stove. | Consumption of Fuel per Hour in Kilogrammes. | Cubic Metres of Air given off per Minute. | Temperature of Air at Outlet in degrees Centigrade. | Temperature of Air at Inlet in degrees Centigrade. | No. of Cubic Metres of Air which would be heated from 0° to 1° C. by 1 Kilogramme of Fuel. |
|---|---|---|---|---|---|
| General Iron Foundry Company | 1·5 coke<br>2· coal | 10·8<br>11·3 | 49·<br>56· | 23·<br>22·5 | 9,505<br>9,406 |
| Musgrave's Slow Combustion "No. 2, Rough" | 1·5 coke<br>2· coal | 14·7<br>17· | 53·<br>59·5 | 21·<br>20· | 15,603<br>16,507 |
| Musgrave's, No. 3. | 1·5 coke | 13·1 | 63·5 | 25· | 16,324 |
| Guerney's Patent, No. D (small) | with water<br>without water<br>without water | 11·7<br>13·9<br>15·7 | 47·<br>50·5<br>62· | 19·5<br>20·<br>20·5 | 10,963<br>14,274<br>15,811 |
| | 1·5 coke<br>1·5 coke<br>2· coal | | | | |

Table of the Results of Experiments on Stoves—*cont.*



| Name of Stove. | Consumption of Fuel per Hour in Kilogrammes. | Cubic Metres of Air given off per Minute. | Temperature of Air at Outlet in degrees Centigrade. | Temperature of Air at Inlet in degrees Centigrade. | No. of Cubic Metres of Air which would be heated from 0° to 1° C. by 1 Kilogramme of Fuel. |
|---|---|---|---|---|---|
| Guerney's Patent, No. C. with water | 1·5 coke | 13·1 | 56· | 21· | 15,190 |
| Guerney's Patent, No. C. without water | 1·5 coke | 15·7 | 61·5 | 19·5 | 21,470 |
| Baudon, Lille | ·5 coke | 7·3 | 40· | 22·5 | 13,356 |
| Boutier, Lyons | 1· coke | 10·1 | 40· | 19· | 11,074 |
| | 1· coke | 11·0 | 42· | 19· | 13,137 |
| Jolly, Paris | 1·66 coke | 10·3 | 49·5 | 22· | 8,647 |
| | 1·25 anthracite | 10·6 | 54·4 | 24· | 12,864 |
| Gas stove, Phillips, London | 341 litres gas | 4·5 | 39· | 20· | 13,138* |

* By 1 cubic metre of gas.

*Note.*—1 cubic metre = 35·3 cubic feet.
1 kilogramme = 2·2 pounds.

Taking the average per-centage composition of the fuels used to be as follows:—

| | Carbon. | Hydrogen. | Oxygen. |
|---|---|---|---|
| Anthracite | 91·4 | 3·3 | 2·7 |
| Newcastle coal | 80·3 | 5·5 | 9·0 |
| Coke | 93 | — | — |

We have the following theoretical results:—

Theoretical amounts of heated air from fuels.

Cubic metres of air raised from 0° to 1° C. by 1 kilogramme of anthracite = 25,958
Cubic metres of air raised from 0° to 1° C. by 1 kilogramme of coal = 24,668
Cubic metres of air raised from 0° to 1° C. by 1 kilogramme of coke = 23,242

These figures show that the Guerney C. stove gave out rather more than nine-tenths of the heat due to the combustion of a given quantity of coke, whereas some others gave scarcely half of that quantity.

No experiments were made with ordinary open fireplaces, but these probably do not economise more than one-fifth or one-sixth of the heat.

Vide General Morin's experiment with Capt. Galton's grate, in Report on Class 24.

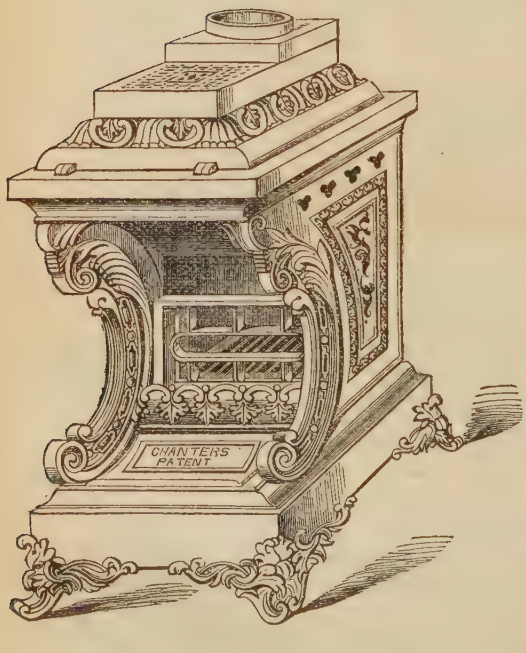
Capt. Webber and Mr. Rowden on Testing House.

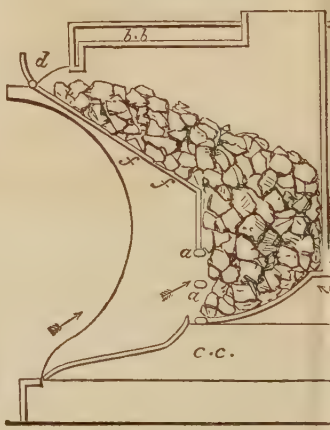
Unfortunately there was only one gas stove sent for trial, but as this one gave a good result, viz., 13,128 cubic metres out of 16,477, the theoretical quantity, it may fairly be taken for comparison with the stoves burning coal and coke.

Result of gas stove.

It will be seen in the table that the combustion of one cubic metre of gas generated about the same quantity of heat as the combustion of one kilogramme of coke in a stove of ordinary construction. The cost of 1 cubic metre of gas in Paris is 30 centimes, and of 1,000 kilogrammes of coke 30 francs, or 3 centimes per kilogramme. Hence in this town heating by gas costs 10 times as much as heating by coke with a very moderately constructed stove. In London the price of gas of about the same quality is about 1·7 of a penny per metre, and the price of coke about ·23 of a penny per kilogramme, so the costs of equivalent amounts of heat as obtained from coke and gas are in the ratio of 1 to 7·3.

The following are brief descriptions of the various stoves sent for trial:—




SECTION.

*a, a.* Open grate. *b, b.* Hot-air c
at back, which is continued aro
sides. *c, c.* Ash-pan. *d.* Door for c

CHANTER'S PATENT HOT-AIR STOVE.—MANUFACTURED BY THE GENERAL IRON FOUND
COMPANY, 43, UPPER THAMES STREET, LONDON.

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Chanter's stove, description.

This stove has two cases, an inner one which forms the fireplace and an outer one perforated for the passage of air. These enclose between them a space where the air becomes heated and finds it way out through the perforations at the top. The grate is charged by the door *d* (see section), and much of the fuel remains on the inclined surface *f f*. As the coke in the grate is consumed that on the bed *f f* slides down, and thus the fire maintains itself at nearly the same height for a considerable time, but if it should not so slide down it is easily moved by an iron rod. The chief features of this stove are its open fireplace and the inclined bed *f f*.

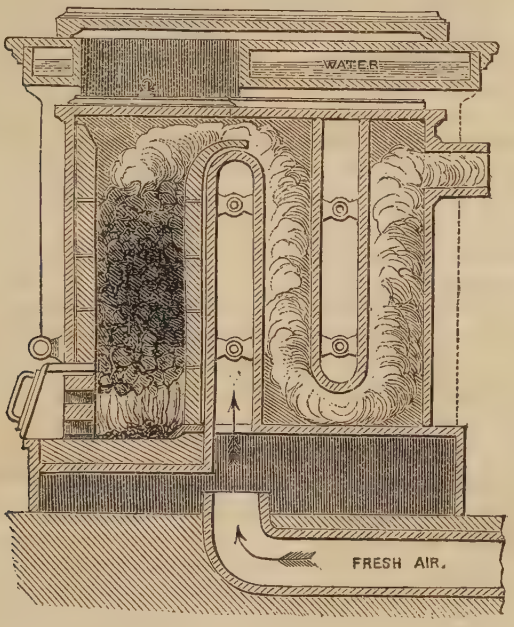


Fig. 1.

MUSGRAVE'S SLOW COMBUSTION STOVE.—MANUFACTURED BY MUSGRAVE BROTHERS, BELFAST.

Musgrave's stove, description.

The fireplace of this stove is lined with fire clay, and unlike most other fireplaces it has no bars, the bottom being lined with fire brick. A rectangular opening about 4 inches deep and the width of the fireplace admits air at the bottom. The quantity of air passing through this opening is regulated by a damper which slides on its hinges to the right or

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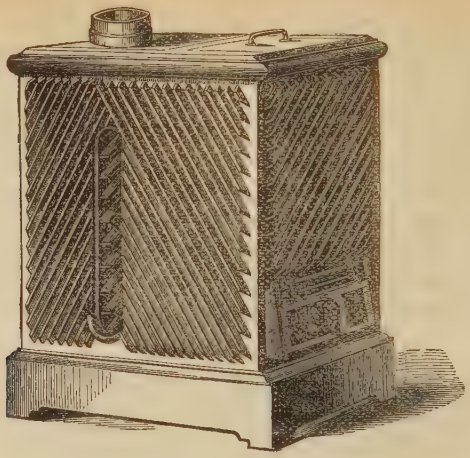


Fig. 2.

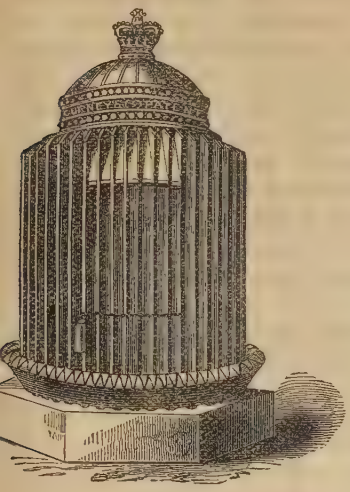
left. (See Fig. 2.) This damper also opens upwards for the removal of the ashes. The fire is charged at the top, the opening for that purpose being closed by a horizontal sliding door. Immediately at the back of the fireplace is an air chamber connected below with a pipe leading under the floor to the external air, but open to the air of the room at its sides. A second chamber likewise open at the sides but closed at the top and bottom divides the remaining portion of the stove into two flues. The outer case is cast with a number of ribs to afford a larger heating surface as in the Guerney stove.

Peculiarities claimed for Musgrave's stove.

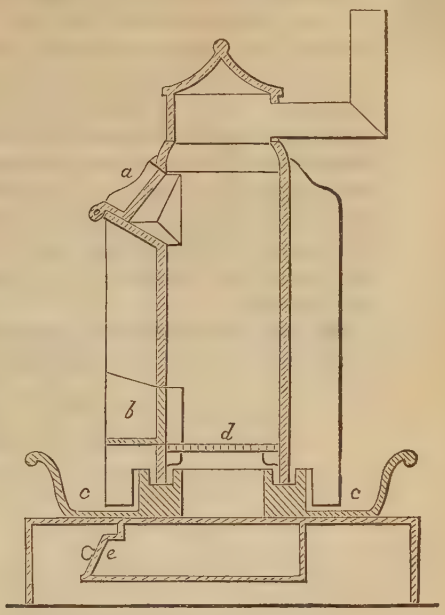
The chief features of this stove are:—

1. It requires very little attention. It gives off a uniform heat without being charged at regular intervals with small quantities of fuel. The air is so perfectly regulated by the damper that a large quantity of fuel may be placed in the fire-place without consuming more rapidly than a smaller quantity. In this way a large body of fire is kept in a state of slow combustion, which appears to be the most advantageous way of burning fuel for heating purposes.
2. Fresh air is provided from the outside of the room, and is not discharged till warmed, thus to some extent avoiding cold draughts from doors and windows, &c.
3. The fire-place is lined with thick fire-bricks, which modify the effects of any changes in the fire.
4. The hot air and gases from the fire do not pass immediately to the flue, but first travel round the two heating chambers, thus affording an additional heating surface.

ERNEY'S PATENT STOVE.—MANUFACTURED BY THE LONDON WARMING AND VENTILATING COMPANY, 12, ABINGDON STREET, WESTMINSTER.



GENERAL VIEW.




SECTION.—*a.* Door for charging. *b.* Door for cleaning out the fire-place. *c, c.* Pan for water. *d.* Fire-bars. *e.* Damper.

Guerney's stove, description.

The body of this stove is in the form of a hollow cylinder, on the exterior surface of which are cast a number of flanges which radiate from its axis (see cuts). This cylinder rests on the internal edge of an annular pan, and the flanges dip into the water with which the pan is filled. This pan rests on a hollow pedestal, which contains a chamber fitted with a sliding damper and serving as the ash-pit.

There are two doors in the body of this stove, one at the top for charging, and the other at the bottom for clearing out the fire when necessary. On a level with the bottom of the lower door are the fire bars.

Peculiarities claimed for the Guerney stove.

The points to be noticed in this stove are:—

1. The very large amount of heating surface afforded by the flanges.
2. The large amount of water evaporated by the heat conducted downwards by these flanges. The amount of evaporation will be in proportion to the amount of heat given out by the stove, and so at whatever heat the stove is kept the air will not become unpleasantly dry.

Comparisons of results with and without water.

On comparing the results obtained by these stoves with and without water it will be seen that about 25 per cent. of

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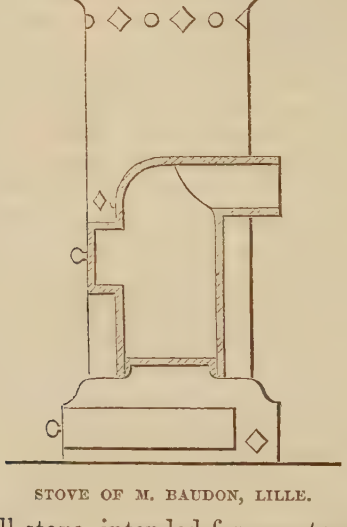
the heat is rendered latent by evaporation, but this heat will necessarily again be developed in distant parts of the room as the temperature of the air containing the moisture is lowered by contact with cold air, so that what appears from the tables to be a loss of heat from using water is really not the case. On the other hand, a large room will probably be more thoroughly warmed in parts distant from the stove by the aid of this latent heat, because if the whole of the heat be imparted to the air it is evident that the air will become more rarefied than when a portion is held by the vapour of water, and therefore there will be a greater tendency for the air to rise and heat the top of the room without extending far laterally.

It was necessary to experiment on the stoves without water in order to compare the results with others.



STOVE OF M. BAUDON, LILLE.

Baudon's stove.

This is a small stove intended for apartments. The fire-place is small and made of cast iron. This is enclosed in a case of sheet iron perforated at the top and bottom to admit of an upward current of air. The fire is charged through a door in the front of the stove which may if required be left open.

*Stove of M. Boutier, Lyons.*

Boutier's stoves.

No. 1 simply consists of two cylinders, one within the other, with a space between for the passage of air. The *external* one is perforated at the top and bottom. The internal one forms the fire-place, and is closed at the top by a cover. The fire is charged by removing this cover. In No. 2 the heated products of combustion, instead of passing

directly from the top into the flue can by means of dampers be made to descend between the two cases and pass into another flue at the bottom. In this stove the external cylinder is not perforated.



*Stove of M. Jolly, Paris.*

Jolly's stove.

This stove differs from most others in that no air is allowed to circulate between the two cylinders. Each cylinder is closed by a separate cover fitting as nearly air-tight as possible. The internal one is lined with fire clay about half way up, and forms the fire-place. A flue leads from its top and passes air-tight through the outer case.

To light this stove the fire-place, which is about 2 feet deep and 16 inches in diameter, is filled with coke, and a little charcoal is placed on the top. A few shavings or small pieces of wood ignite the charcoal, when the two covers are put on, and the fire gradually burns downwards, the air being supplied as usual through bars at the bottom.

Charged in this way with 10 kilogrammes of coke, the stove may be made to burn uniformly for from 12 to 15 hours without any other attention than partly shutting off the damper after the fire has fairly started. The rate of combustion can be modified by the damper to suit almost any requirements.

The stove also burns anthracite coal remarkably well. In one experiment it was charged with 20 kilogrammes of this coal, and it continued burning, giving off a uniform heat, for 30 hours. The burning of anthracite was tested at the suggestion of Mons. Clerget, President of the Jury of Class 24.

*Phillips' Gas Stoves, 55, Skinner Street, London.*

Phillips' stove.

This was the only gas stove sent for trial. No provision was made for carrying off the products of combustion, which is a great objection to its use, particularly in badly ventilated rooms. Otherwise the arrangements of the stove were good, and the results satisfactory for one consuming gas.

## Experiments on Gas, including Meters, Burners, &c.

Remarks on meters.

In all quantitative experiments it is absolutely necessary that accurate measures should be employed. Measures of weight have now attained great perfection. Even in the most ordinary every day use no one is satisfied with a balance which does not "turn" with an extra ounce when weighing 20 pounds, nor is a weight allowed to vary in the same proportion; yet the public generally are quite contented to use another measure of almost equal importance, which is per-

Capt. Webber and Mr. Rowden on Testing House.

mitted by law to vary nine times that amount, and in practice a variation of 60 or 70 times as much is not uncommon.

Standard measures.

From time immemorial nations have taken means for obtaining correct measures of length, weight, and capacity, and for that purpose have established standards which have been deposited in public places, but the difficulty of reproducing these measures and of compelling their adoption have, till very recent times, baffled all attempts at legislation, and every new attempt has left the matter in worse confusion than before.

These difficulties having proved so great with measures of weight, length, and capacity for liquids, it is not, perhaps, surprising that the measuring of gas should have been so long left in an unsatisfactory state, both as regards a national standard from which others could be taken, and the measures used between producers and consumers.

Standards of measurement in England;

Even at the present time Great Britain is the only nation which has thoroughly taken up the matter of gas measurement, and we are certainly far in advance of others in this respect.

in France.

To show the laxity on this point in France, we find that late in the year 1864 some attempts were made by the Prefect of the Seine to improve the gas meters of Paris, and he sent a circular letter to the manufacturers, requesting them in constructing their meters to limit the error within nine per cent., with an intimation that it would, perhaps, be necessary to enforce such a rule. However, it was found that such a step would have abolished all the meters of Paris. An inquiry only two years ago proved that the range of error was 23 per cent.

Parliamentary standard.

In 1859 the Parliament of Great Britain passed an Act for regulating the measures used in the sale of gas. One of its provisions was that a national standard unit of capacity should be made, and that gas-holders should be provided for verifying gas meters, measuring the said unit and decimal parts of it.

The task of producing a standard unit of capacity was undertaken by the Astronomer Royal, who made a vessel which exactly contained 62·321 lbs. of distilled water at a temperature of 62° F., the barometer being at 30 inches, that is, one cubic foot. A difficulty then presented itself, none of the gas-holders in common use could be depended on, they not only varied three or four per cent. as compared one with another, but the parts of the same holder differed largely when tested by the standard cubic foot. It was therefore found necessary to make a new gas-holder, and this task was entrusted to Mr. G. Glover, of Ranelagh-road, Pimlico,

Mr. Glover's standard gas holder.

London, who produced and patented in 1860 a gas-holder which was deposited in the Exchequer. Others were also made for Dublin and Edinburgh.

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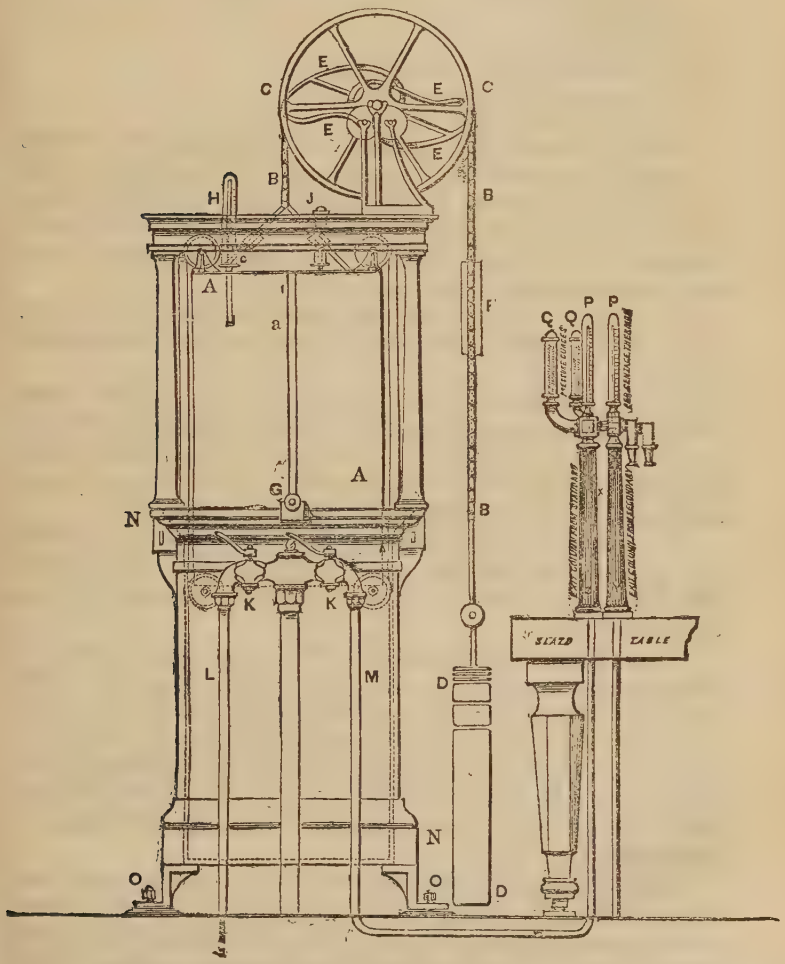
A fac-simile of this standard holder and its accompanying testing table were placed in the Testing House by Mr. Glover for the purpose of testing gas meters, and for verifying the meters used in gas experiments.

The following is a brief description:—




A, A. An inverted cylindrical vessel called the bell.

*a.* Scale for reading off the amounts of gas which have passed from the bell.

B, B. A flat band of steel supporting the bell, to which it is attached by three rods which can be lengthened or shortened by screws to set the bell perpendicular.

Description of Glover's standard holder.

CAPT. WEBBER AND MR. ROWDEN ON TESTING HOUSE.

Description of Glover's standard holder.

C. Wheel with axle on friction wheels.
D. Counterpoise to bell, with moveable weights on the top.
E, E. Spiral pulleys on axis of wheel. To one of these the weight F is attached, so that while the bell sinks in the water and loses part of its weight, the distance at which F acts from the axis is shortened, and its power as a counterpoise thereby diminished.
G. Microscope for reading the scale.
H. Thermometer on bell. Its bulb is in the interior.
J. Pressure gauge on bell.
K. K. Taps, one for filling the holder, and the other for allowing the gas to pass to the meter.
L. Inlet pipe.
M. Outlet pipe.
N. N. Cistern for water.
O. O. Screws for adjusting the level of cistern.
P. P. Thermometers on testing table.
Q. Q. Pressure gauges on testing table.

The bell is made of an anti-corrosive alloy, so no change in capacity can occur by the action of water or gas. This alloy has the property of rising quite dry out of the water, thus eliminating another source of error, viz., the rapid contraction in volume of the enclosed gas by the loss of heat due to evaporation on the bell as it rises.

The cistern and taps are also lined with the same alloy. The bell is made stout enough to resist all reasonable pressures.

The thermometers require special notice. Their long bulbs render them very sensitive. An important additional scale is added by which the volumetric correction for any increase or diminution of temperature, while the gas passes from the holder to the meter can at once be read off.

The scale on the bell is graduated into cubic feet, tenths and hundredths, and one can readily read off thousandths. The division has been verified by comparison with the national standard.

The testing table is provided with two columns, each of which carries a thermometer and pressure gauge. The bottom of one of these is connected with the outlet pipe of the gas holder, and its top with the inlet pipe of the meter, which is being tested. The top of the other column is in connexion with the outlet pipe of the meter, and the gas which has passed the meter is carried from the bottom to be consumed.

Thus the requisite data for accurately testing a meter can be obtained, viz., the amount of gas passing from the holder at a given pressure and temperature, and the pressures and temperatures of the gas immediately before and after it has passed the meter.

In the construction of this holder nothing appears to have been omitted which could make it as perfect a standard for proving gas meters as it is possible to obtain. Constant use

for some months proved that the alloy resists the corrosive actions of gas and water, and that it leaves pure water quite dry. The counterpoises and other moving parts are so arranged that no difference in pressure on the enclosed gas could be detected when the bell was at various depths in the water. The thermometers immediately marked any change of temperature. The graduations on the scale are accurately cut, and indeed the whole finish of the instrument is such as reduces to a minimum the physical obstacles which have so long rendered the measurement of gas a matter of the greatest uncertainty.

Peculiarities claimed for Glover's standard holder.

The specialties of the instrument are,—

1. The measuring chamber or bell resists the corrosive action of gas and water.
2. No paint used on the bell.
3. No water adheres to the bell.
4. The bell is stout enough to maintain its shape against any reasonable force.
5. The scale is cut on the bell itself, so no tampering with it is possible.
6. The bell is truly cylindrical, having been made on a mandril and drawn through a steel collar.
7. The construction of the thermometers and the scale for allowances for variations in temperature.

### *Testing of Gas Meters.*

Mr. G. Glover, of Ranelagh Road, Pimlico, London, was the only manufacturer who sent meters to be tested.

One may fairly suspect that a reason which influenced makers in refusing to send meters for trial was the undoubted laxity which prevails in gas measuring.

Necessity for good gas meters.

In London alone about 14,000,000,000 of cubic feet of gas are consumed annually, for which a sum of 2,800,000*l.* is paid. It is therefore surprising that more care is not taken to provide reliable gas meters.

Glover's dry meters.

Mr. Glover is a manufacturer of dry meters only, so no opportunity presented itself of comparing their accuracy with that of wet meters under various circumstances, but the perfection to which that maker has brought his meters prevents the possibility of those extravagant errors which are well known to exist where wet meters are used. The stamp on a dry meter is a guarantee of its accuracy, as nothing short of breaking into the instrument can alter its action, but the stamp on the wet meter merely implies that if the instrument is perfectly horizontally fixed and the water *kept* at a certain level it will register accurately. Now as neither of these conditions is attainable in practice it follows that as a measurer of gas the wet meter is defective.

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The working parts of Mr. Glover's meters are constructed of anti-corrosive metal. Other improvements in the valves, leathers, &c. he has secured by a patent.

The following figures are averages of three observations made on each meter :—

Meter for five lights registered ·36 per cent. or one in 280 too little.

Meter for three lights registered ·2 per cent. or one in 500 too little.

## The Relative Illuminating Powers of the London and Paris Standards of Light.

English standard of light.

The English standard of illuminating power is the light of a sperm candle burning 120 grains per hour. The candles used for the following experiments were supplied by Mr. Field of Lambeth, who manufactures candles expressly for photometric experiments. From their appearance when cool after use they seemed very pure, and they burned with great regularity.

Bunsen's photometer.

This candle is used with the ordinary Bunsen's photometer, which is a graduated rod, at the ends of which are placed the two lights to be compared. A moveable disc of paper with a small central ring rendered translucent by some oily or waxy substance is placed in a line between the two lights. By sliding this disc along the rod till the central spot either entirely disappears or the lights on both sides have the same relative intensities when compared with the surrounding parts, the operator can judge when the two flames shine equally brightly on their respective sides of the disc ; then referring to the scale below, the pointer attached to this disc shows how many times greater one light is than the other, these numbers having been previously calculated from the well known law that the intensity of light varies inversely as the squares of the distances.

French standard of light.

The French standard of illuminating power is the light given by a moderator lamp of stated dimensions, burning 42 grammes of pure colza oil per hour.

These dimensions are as follow :—

| | | |
|---|---|---|
| Exterior diameter of wick-holder - | 23·5 | millimetres. |
| Interior „ „ - | 17 | „ |
| Total height of glass chimney - | 290 | „ |
| Distance from the shoulder of chimney to its base - - - - | 61 | „ |
| Exterior diameter immediately below the shoulder - - - | 47 | „ |
| Exterior diameter at the top of the chimney - - - - | 34 | „ |
| Mean thickness of glass - - | 2 | „ |

The ordinary wick is used, but it must contain 75 strands, and a decimetre in length must weigh 3·6 grammes.

A new wick must be used each time the lamp is lighted. It should be made even at the top and set to a height of 10 millimetres above the holder. The shoulder of the chimney should be about seven or eight millimetres above the top of the wick. A lamp thus arranged will consume about the required quantity of oil per hour. Any variation from this quantity may be corrected by slightly raising or lowering the chimney as the case may require.

If the lamp burns more or less than 42 grammes per hour an allowance may be calculated for it, provided the amount consumed is between 38 and 46 grammes, but beyond these margins no calculation is permitted. To determine the consumption of oil without removing the lamp from its photometer, a special balance is constructed by M. Deleuil, of Paris. One of its arms is forked at the end to receive the neck of the lamp, which is supported by a pan hanging from two knife edges, one on each arm of the fork.

M. Deleuil's balance.

The photometer used is one arranged by MM. Dumas and Regnault. The two lights to be compared are placed on the same side of a vertical dark screen, a small opening in which is filled by a plate of glass coated with a solution of starch. The two flames are placed at equal distances from the plate of glass, and in such positions that the line joining them is parallel to the plane of the glass, and the two lines joining the centres of the flames and the centre of the glass meet at an angle of from 30° to 40°, these three lines being horizontal.

Dumas and Regnault's photometer.

A vertical strip of thin wood is fixed in front of the screen so as to allow each light to shine only on one half of the opening.

The experimenter places himself behind the screen where he can readily see which light is burning more brightly, and by regulating the consumption of one or the other he is able to equalize them.

In testing gas in England a standard candle is placed at one end of the photometer, and at the other an argand burner of definite dimensions and with a chimney of a given height, is made to consume a given number of cubic feet of gas per hour. The two lights are then compared, and after proper allowances for the variation from a consumption of 120 grains per hour by the candle, the gas is said to be of so many candle power. In Paris a standard argand burner is made to consume sufficient gas to give the same light as the standard moderator lamp above described; the quality of the gas will therefore be inversely as the consumption.

Testing gas by English method;

by French method.

Capt. Webber and Mr. Rowden on Testing House.

For the results of the following table a standard moderator lamp, lent by M. Deleuil, was used. Each result is the mean of observations at intervals of two minutes, extending over one hour, and in most cases made by two observers.

Comparison of standards.

TABLE of COMPARISON between ENGLISH and FRENCH STANDARDS of LIGHT.

| No. of Observation. | English Standard, Candle burning 120 grains per hour. | French Standard, Lamp consuming 42 grammes per hour. |
|---|---|---|
| 1 | 1 | 9·6 |
| 2 | 1 | 9·73 |
| 3 | 1 | 9·5 |
| 4 | 1 | 9·5 |
| 5 | 1 | 9·92 |
| 6 | 1 | 9·7 |
| 7 | 1 | 9·81 |
| 8 | 1 | 9·59 |
| | Average - | 9·66 |

To check this result the candle was compared with the light of the Paris standard argand, consuming 105 litres of gas per hour, and which ought by the Paris gas regulations to give an illuminating power equal to that of the lamp.

The average of several observations gave—

| English Standard Candle. | French Standard Burner consuming 105 litres per hour. |
|---|---|
| 1 | 9·56 |

This differs from the other result by one-tenth of a candle.

## ADVANTAGES of the FRENCH SYSTEM over the ENGLISH SYSTEM of TESTING the QUALITY of GAS.

Advantages of French method.

The light of a candle is very irregular even with a uniform consumption. Every draught affects not only the amount burned, but the amount of light evolved by a given weight of the candle. The light also depends on the shape of the wick in the flame. By managing the wick one may obtain a variation in illuminating power of at least 10 per cent. after making due allowance for the increased or decreased consumption. Even although any individual experimenter by constant practice with his candles under certain conditions may be able to depend upon his results as compared one with another, yet what is his standard of light may not be that of another

experimenter whose candle is burning under different conditions. Thus while a candle is subjected to so many uncontrollable influences it can form no universal standard of light. An experimenter has no control over the amount consumed by his candle, yet beyond a certain limit it is not sufficiently accurate to calculate the illuminating power due to 120 grains from that obtained by a greater or less consumption. The above objections apply, even supposing that the material and wicks of the candle are in every case precisely similar, which in practice is well known not to be the case.

When comparing the flame of an argand gas burner with that of a candle there are two lights very different in power, size, and quality, whereas for accuracy the flames should be as nearly as possible on an equality in these respects.

With the standard moderator an ordinary draught, such as would considerably disturb the burning of the candle, would be harmless. The wick is always as nearly as possible under the same conditions; its height is always the same, and being only a carrier of oil and quite below the flame it cannot influence the light as does the wick of a candle, which is in the flame and gradually burning away. Further, one is able to test the wick of a moderator before using it, but the wick of a candle must be entrusted solely to the care of the makers. In power, size, and quality of the light the standard moderator is as nearly as possible similar to the gas burner. As regards the purity of the combustible, it appears that purified colza oil of commerce is as much to be depended upon as sperm candles.

### *Quality of Paris Gas.*

Quality of gas in Paris.

From a series of observations made by the standard candle and the London argand for 12-candle gas, the following results were obtained.

| Number. | Candle Power of Argand consuming 5 cubic feet per hour. |
|---|---|
| 1 | 12·4 |
| 2 | 12·59 |
| 3 | 12·3 |
| 4 | 12·55 |
| 5 | 12·46 |
| 6 | 12·4 |
| August 15, morning - | 13·4 |
| „ 15, afternoon | 13·6 |
| „ 16, morning - | 12·9 |

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Omitting the results of the 15th and 16th August, on which days the gas was much above the ordinary illuminating power, the average result is 12·45 candle power.

*Experiments on Gas Burners.*

The standard burner.

The standard light used in these experiments was that of a 12-candle argand burner, such as is used for testing gas in London, consuming 5 cubic feet of gas per hour. It was lent by Mr. G. Glover.

This standard has been taken as equal to 12·45 candle power, but should the gas have varied the results would as nearly as possible have the same value.

The photometer.

The photometer was placed at the disposal of the Testing Committee by Mr. Leoni, of St. Paul's Street, New North Road, London. It consisted of two excellent wet meters, one at each end of the bar. From the tops of these ran two vertical hollow bars which served the double purpose of supports to the bar and outlets from the meters. Two stop-cocks in each of these rods regulated the gas, the lower ones being supplied with screw adjustments. Between the two cocks the pressure gauges were connected.

The meters were adjusted at intervals of seven or eight days by Mr. Glover's standard gas holder, which has already been noticed.

Manner of carrying on experiments.

In making an experiment the standard argand was screwed above one meter and made to consume 5 cubic feet per hour. The burner to be tested was then fastened above the other meter, and its consumption regulated as required. Results were thus worked out:—Suppose the pointer of the moveable disc marked 1·2 on the side nearer the standard; this proved that the light being tested was 1·2 times the power of the standard, and so $12{\cdot}45 \times 1{\cdot}2 = 14{\cdot}94$ candle power. If the pointer marked 1·2 on the side farther from the standard it proved that the standard was 1·2 times greater than the other, and therefore that the latter was $12{\cdot}45 \div 1{\cdot}2 = 10{\cdot}38$ candle power. The advantages of using a gas burner for comparative results with gas jets are,—

1. The lights are as nearly as possible under the same conditions of intensity, quality, and size.
2. Expedition in obtaining results.
3. Less error from the variation in the quality of gas. Within the small margins allowed for variation by the Paris gas regulations the error would be scarcely appreciable as a diminution in the light of the burner experimented on would be almost counterbalanced by a diminution in the light of the standard.

Only one quality of gas could be used, hence the experiments are necessarily imperfect.

TABLE I.—ARGAND BURNERS.

| Name of Maker. | Diameter in Inches. External. | Internal. | Of Centres of Ring of Holes. | Number of Holes. | Size of Holes. | Consumption in cubic Feet per Hour. | Pressure at Exit from Burner. | Illuminating Power. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| Sugg's, for 12-candle gas | 1·1 | ·45 | ·825 | 15 | ·06 | 4 | ·03 | — | |
| | | | | | | 5 | ·04 | 12·4 | Glass 7 inches high in every case. |
| | | | | | | 6 | ·05 | 16·8 | |
| Sugg's, for 14-candle gas | 1·1 | ·47 | ·825 | 15 | ·06 | 5 | ·05 | 12·45 | |
| | | | | | | 6 | ·06 | 16·4 | |
| Sugg's, for 16-candle gas | 1·1 | ·55 | ·825 | 15 | ·06 | 5 | ·03 | 11·9 | |
| | | | | | | 6 | ·04 | 16·2 | |
| Sugg's, for 18-candle gas | 1·1 | ·58 | ·825 | 15 | ·06 | 5 | ·04 | 11·3 | |
| | | | | | | 7 | ·05 | 20·5 | |
| Sugg's, in brass | 1·1 | ·5 | ·825 | 15 | — | 5 | ·05 | 10·4 | Flame very pointed. |
| | | | | | | 6 | ·06 | 15·5 | |
| Sugg's, in porcelain | — | — | ·825 | 38 | — | 5 | ·05 | 10·0 | |
| | | | | | | 7 | ·065 | 19·9 | |
| Sugg's, with continuous opening instead of holes | 1·2 | ·57 | ·9 | — | ·012 | 5 | ·2 | 11·9 | Short flame. |
| | | | | | | 7 | ·28 | 19·3 | Flame forked. |
| Sugg's, another size | 1·2 | ·65 | ·9 | — | ·017 | 5 | ·15 | 9·3 | Short flames. |
| | | | | | | 7 | ·21 | 17·4 | |
| Sugg's, small argand | ·8 | ·36 | ·6 | 20 | ·03 | 3 | ·06 | 9·1 | |
| | | | | | | 3·5 | ·07 | 9·8 | |
| | | | | | | 4 | ·08 | 11·4 | Very good flame. |
| | | | | | | 4·5 | ·1 | 13·0 | |
| Leoni's, for 14-candle gas | 1·13 | ·5 | ·85 | 15 | ·06 | 5 | ·05 | 12·3 | |
| | | | | | | 6 | ·07 | 15·5 | |
| | | | | | | 7 | ·1 | 19·2 | Very good flame. |
| | | | | | | 8 | ·11 | 25·0 | |
| Leoni's | 1·15 | ·6 | ·87 | 36 | ·02 | 5 | ·55 | 8·2 | |
| | | | | | | 6 | ·7 | 10·4 | A large portion of the flame blue. |
| | | | | | | 7 | ·9 | 13·7 | |
| Leoni's | 1·1 | ·75 | ·93 | 40 | ·025 | 5 | ·2 | 11·3 | |
| | | | | | | 6 | ·27 | 16·2 | |
| | | | | | | 7 | ·35 | 19·9 | |
| Leoni's | 1·5 | ·85 | 1·18 | 60 | ·025 | 8 | ·45 | 17·4 | |
| | | | | | | 10 | ·65 | 26·1 | Glass 10×2·5. |
| | | | | | | 11 | ·8 | 29·8 | |
| | | | | | | 12 | ·94 | 33·6 | |
| Leoni's | ·95 | ·47 | ·75 | 24 | ·025 | 4 | ·3 | 6·9 | |
| | | | | | | 5 | ·4 | 10·4 | |
| | | | | | | 6 | ·5 | 16·2 | |
| | | | | | | 6 | ·7 | 11·0 | The gas passed through a tube in centre of flame and so became heated before it issued from the jet. |
| | | | | | | 7 | ·9 | 16·3 | |
| Benham's, argand, of globe light | — | — | 1·0 | 30 | — | 6 | ·35 | 10·7 | The central pipe was left in and gas admitted from below. |
| | | | | | | 7 | ·5 | 16·2 | |
| | | | | | | 6 | ·33 | 11·3 | The central pipe entirely removed and the burner used as an ordinary argand. |
| | | | | | | 7 | ·45 | 16·8 | |
| Schaffer and Walcker, in porcelain | — | — | ·75 | 32 | — | 5 | ·1 | 11·9 | |
| | | | | | | 6 | ·17 | 16·2 | |
| | | | | | | 7 | ·23 | 21·2 | |
| Bengel's | ·95 | ·55 | ·75 | 40 | ·025 | 3 | ·06 | 3·8 | Flame almost all blue. |
| | | | | | | 4 | ·09 | 7·8 | Flame very blue. |
| | | | | | | 5 | ·1 | 12·45 | Flame good. |
| | | | | | | 6 | ·14 | 16·2 | |
| | | | | | | 7 | ·18 | 20·5 | |
| Bengel's, the standard or Bengel burner for testing gas of Paris | ·87 | ·37 | ·65 | 30 | ·025 | 3 | ·09 | 5·8 | |
| | | | | | | 3·5 | ·09 | 9·5 | See detailed description below. |
| | | | | | | 4 | ·1 | 10·9 | |
| | | | | | | 5 | ·12 | 13·7 | |

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Argand gas burners.

*The Argand Burners of Mr. Sugg, of Westminster, London,* were made for consuming five cubic feet per hour of gases of various qualities. The ring in which the holes for the exit of gas were drilled was made of earthenware, and so not liable to corrosion. It was mounted in brass and the whole burner well finished. Two of the burners had circular slits instead of holes, but they did not appear to be an improvement on the ordinary form, at least with Paris gas.

*In the burners of Mr. Leoni* his patent adamas supplied the place of the earthenware ring. This material is particularly well adapted for gas burners. It stands heat perfectly, does not corrode during years of use, and is sufficiently hard to resist even very rough usage. The gauges are thoroughly to be depended on. His "six-tenths pressure jet" was tested by a gauge made by Deleuil, and the difference between the diameters of two, which varied most out of about 20 taken at random, was less than two-thousandths of an inch. The variation in the ordinary jets was also very small.

French standard argand burner.

*The Bengel Standard Burner.*—This argand is that used for all gas testing in Paris. It was said that this burner was the best for consuming 105 litres of gas per hour, but a small argand sent by Mr. Sugg seems better.

The following results were obtained:—

For equal quantities of light,—

| | | |
|---|---|---|
| Sugg's small argand, with 7-inch chimney, consumed per hour | 101 | litres. |
| The Bengel burner consumed per hour | 105 | „ |
| The English Standard 12 candle argand, 7-inch chimney, consumed per hour | 115·5 | „ |

The dimensions of the Bengel burner are as follow:—

| | | |
|---|---|---|
| Total height of burner | 80 | millimetres. |
| Height of the cylindrical part | 46 | „ |
| Exterior diameter of cylindrical part | 22·5 | „ |
| Interior diameter of current of air | 9 | „ |
| Diameter of the circle passing through the centres of the holes | 16·5 | „ |
| Diameter of holes | 0·6 | „ |
| Number of holes, 30. | | |
| Height of glass chimney | 200 | „ |
| Diameter of „ „ top | 52 | „ |
| Diameter of „ „ bottom | 49 | „ |
| Thickness | 3 | „ |
| Distance from bottom of chimney to top of burner | 31 | „ |

*Note.*—1 millimetre = 0·0393 inch.

The cylinder forming the burner is of porcelain and it is enveloped below the support for the chimney, by a thin case of porcelain, which tapers downwards from the base of the chimney to the base of the cylinder. For admission of air this case is perforated by 30 holes of 3 millimetres diameter.

Argand burner in Benham's globe light referred to in Report on Class 24.

The results of the experiments with the burner of Benham's globe light seem to prove that no advantage in illuminating power is gained by his arrangement for passing gas through the red hot tube in the centre of the flame, although it is a very convenient way of supplying gas to his burner.

TABLE II.—BATSWING BURNERS.

| Name of Maker. | Gauge of Opening. | Width at Base of Opening. | Height of Opening. | Consumption per Hour in Cubic Feet. | Pressure at Exit of Gas. | Illuminating Power. | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | feet. | | | |
| Leoni, No. 4. - | ·012 | ·31 | ·13 | 3 | ·57 | 3·5 | The pressures in this case are not worth notice, as the burners were plugged with wool. Many burners were tested with and without this wool, but with no perceptible difference in illuminating power. |
| | | | | 4 | ·8 | 4·2 | |
| | | | | 5 | 1·05 | 5·0 | |
| „ No. 5. - | ·015 | „ | „ | 3 | ·31 | 5·0 | |
| | | | | 4 | ·46 | 6·2 | |
| | | | | 5 | ·6 | 8·2 | |
| | | | | 6 | ·77 | 8·9 | |
| „ No. 6. - | ·017 | „ | „ | 3 | ·29 | 5·2 | |
| | | | | 4 | ·4 | 7·6 | |
| | | | | 5 | ·05 | 8·5 | |
| | | | | 6 | ·65 | 10·0 | |
| „ No. 8. - | ·02 | „ | „ | 4 | ·33 | 8·3 | |
| | | | | 5 | ·42 | 10·4 | |
| | | | | 6 | ·55 | 12·5 | |
| | | | | 7 | ·66 | 14·9 | |
| | | | | 8 | ·78 | 16·2 | |
| „ Batswing economizer No. 3. | – | – | – | 3 | ·36 | 5·8 | |
| | | | | 4 | ·47 | 8·3 | |
| | | | | 5 | ·65 | 10·4 | |
| | | | | 6 | ·8 | 11·9 | |
| | | | | 7 | ·97 | 14·3 | |
| „ „ No. 4. | ·012 | – | – | 3 | ·24 | 5·4 | This burner gave a very good flame. It required a pressure of 2·5 to cause it to roar. |
| | | | | 4 | ·35 | 8·0 | |
| | | | | 5 | ·45 | 10·6 | |
| | | | | 6 | ·58 | 13·7 | |
| | | | | 7 | ·71 | 15·5 | |
| „ „ No. 6. | ·018 | – | – | 4 | ·15 | 8·0 | Flame flickers. |
| | | | | 5 | ·22 | 11·3 | Flame still flickers. |
| | | | | 6 | ·28 | 14·7 | Flame flickers slightly. |
| | | | | 7 | ·35 | 17·4 | |
| | | | | 8 | ·4 | 19·9 | |
| | | | | 12 | ·77 | 30·0 | Very good flame. |

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Table II.—Batswing Burners—*cont.*

| Name of Maker. | Gauge of Opening. | Width at Base of Opening. | Height of Opening. | Consumption per Hour in Cubic Feet. | Pressure at Exit of Gas. | Illuminating Power. | Remarks. |
|---|---|---|---|---|---|---|---|
| Batswing burner used in all street lamps of Paris - | – | – | – | 3 | ·09 | 6·2 | Flame rather unsteady. |
| | | | | 4 | ·1 | 8·3 | Steady flames. |
| | | | | 5 | ·15 | 10·9 | |
| | | | | 6 | ·2 | 13·7 | |
| | | | | 7 | ·25 | 16·2 | |
| | | | | 8 | ·31 | 18·6 | |
| Sugg's earthenware tips, No. 4. | ·014 | – | – | 3 | ·45 | 3·6 | |
| | | | | 4 | ·63 | 4·7 | |
| | | | | 5 | ·87 | 5·9 | |
| ,, ,, No. 6. | – | – | – | 3 | ·35 | 4·4 | |
| | | | | 4 | ·51 | 5·6 | Roars. |
| | | | | 5 | ·7 | 6·9 | |
| | | | | 6 | ·94 | 8·4 | |
| ,, ,, No. 7. | ·018 | – | – | 3 | ·29 | 4·7 | |
| | | | | 4 | ·42 | 6·3 | Some noise. |
| | | | | 5 | ·55 | 8·0 | Noise increased. |
| | | | | 6 | ·75 | 9·2 | Roars. |
| ,, ,, No. 8. | ·02 | – | – | 3 | ·2 | 5·6 | |
| | | | | 4 | 29 | 7·4 | Considerable noise and unsteadiness. |
| | | | | 5 | ·43 | 9·6 | Noise increased. |
| | | | | 6 | ·57 | 10·8 | Roars. |
| | | | | 7 | ·71 | 12·45 | Roars badly. |
| ,, very large burner - | ·02 | ·45 | ·3 | 4 | ·18 | 8·9 | Flame unsteady. |
| | | | | 5 | ·22 | 11·9 | |
| | | | | 6 | ·28 | 14·9 | |

TABLE III.—FISHTAIL BURNERS.

| Name of Maker. | Diameter of Holes. | Consumption per Hour in Cubic Feet. | Pressure of Gas at Burner. | Illuminating Power. | Remarks. |
|---|---|---|---|---|---|
| | | feet. | | | |
| Leoni, No. 4. - | ·04 | 4 | ·75 | 4·5 | *See* remark in Table II. opposite Leoni's Batswing Burners. |
| | | 5 | 1·0 | 5·0 | |
| | | 6 | 1·35 | 5·5 | |
| ,, No. 5. - | ·047 | 4 | ·47 | 5·3 | |
| | | 5 | ·65 | 6·1 | |
| | | 6 | ·85 | 7·6 | |
| | | 7 | 1·1 | 8·3 | |
| ,, No. 6. - | ·051 | 4 | ·45 | 6·3 | |
| | | 5 | ·6 | 8·1 | |
| | | 6 | ·78 | 9·0 | |
| | | 7 | 1·0 | 10·4 | |

Table III.—Fishtail Burners—*cont.*

| Name of Maker. | Diameter of Holes. | Consumption per Hour in Cubic Feet. | Pressure of Gas at Burner. | Illuminating Power. | Remarks. |
|---|---|---|---|---|---|
| Leoni, No. 7. | ·057 | 4 | ·33 | 8·0 | *See* remark in Table II. opposite Leoni's Batswing Burners. |
| | | 5 | ·44 | 10·3 | |
| | | 6 | ·57 | 12·4 | |
| | | 8 | ·91 | 14·8 | |
| „ No. 8. | ·066 | 4 | ·28 | 8·3 | |
| | | 5 | ·37 | 10·4 | |
| | | 6 | ·54 | 12·5 | |
| | | 7 | ·65 | 14·8 | |
| | | 9 | 1·0 | 17·6 | |
| „ Fishtail economizers, No. 3. | — | 3 | ·16 | 5·4 | |
| | | 4 | ·25 | 7·6 | |
| | | 5 | ·34 | 9·6 | |
| | | 6 | ·44 | 11·3 | |
| | | 7 | ·56 | 13·1 | |
| Sugg's earthenware tips, No. 4. | — | 3 | ·38 | 3·8 | |
| | | 4 | ·6 | 4·6 | |
| | | 5 | ·92 | 4·8 | |
| „ „ No. 5. | — | 4 | ·4 | 6·9 | |
| | | 5 | ·57 | 7·8 | |
| | | 6 | ·74 | 8·3 | |
| „ „ No. 6. | — | 4 | ·3 | 6·9 | |
| | | 5 | ·4 | 9·6 | |
| | | 6 | ·55 | 11·9 | |
| | | 7 | ·71 | 13·0 | |
| „ „ No. 8. | — | 4 | ·11 | 8·9 | The flame very long and flickering. An increase in consumption caused roaring. |
| | | 5 | ·14 | 10·9 | |
| Fishtails set in brass, No. 5. | — | 4 | ·38 | 7·4 | Roars and flickers. |
| | | 5 | ·5 | — | Roars badly. |
| „ No. 6. | — | 4 | ·35 | 6·9 | Roars and flickers. Could not burn more gas without further increasing the roaring. |
| „ No. 7. | — | 4 | ·3 | 8·0 | |
| | | 5 | ·41 | — | Roars badly. |

Batswing and fishtail burners.

Mr. Leoni furnished a very complete assortment of batswing and fishtail burners for gas of all qualities. Like his argand burners above mentioned the tips were made of patent adamas. They gave good flames with very little noise. Two kinds of these burners were tested, one with the tips set in iron but otherwise like common burners, the other with tips set in brass. The latter contained pieces of wool inside for the purpose of lessening the pressure of the gas before it reached the jet. Besides modifying the effect

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of any change in pressure in the gas pipes, this wool appeared of little use. Many burners were tried with and without it, but when the pressure of the gas was checked at a sufficient distance from the burner by the ordinary stop-cock, it appeared to be useless. The same purpose is served by putting a jet of lower gauge inside the other.

Leoni's economizers.

The "Economisers" are two burners so arranged that the jet of one impinges on that of the other at an acute angle. The two jets meet before combustion takes place, and so form one broad sheet of flame. They gave better results with less flickering than any other burners examined. No. 6 batswing economiser, with a consumption of 8 cubic feet per hour, gave a very fine flame of 19·9 candle power, whilst the No. 8 batswing, No. 8 fishtail, and Paris street lamp burner gave 16·2, 16·0, and 18·6 candle power respectively, with the same consumption. This, although not equalling an argand properly constructed for consuming that amount, yet for a cheap burner the result is very good. Consuming 12 cubic feet of gas per hour, it gave a splendid flame with a light only three candle power lower than that of a large argand specially constructed to consume large quantities of gas.

The Paris batswing burner.

The batswing burner, which the Paris Gas Company is compelled to use in all the street lamps of Paris, is specially constructed to consume 140 litres (4·94 cubic feet) per hour. Consuming that quantity it ought to give a light 1·1 times that of the standard moderator. The minimum width and height of the flame must be ·067 and ·032 of a metre (2·63 and 1·25 inches) when consuming that quantity. An illuminating power of 1·1 times that of the French standard will be 10·63 candles. Taking the result given in the table at 5 cubic feet per hour, and calculating the illuminating power at 4·94 cubic feet, we have 10·76 candles, which is about one-tenth of a candle higher than the number above given.

The results given in the table show that this burner, at a consumption of five cubic feet per hour, is superior to all other batswing burners which were tested. Some others gave a light of equal power, but with such an unsteady flame that their use is out of the question. The pressure of gas at the exit was very low, but the shape of the burner admitted this without undue flickering.

Mr. Sugg also sent an assortment of batswing and fishtail burners. It will be seen from the remarks in the tables that

those of a higher gauge, from which the best results ought to have been obtained, would not consume more than 5 cubic feet of gas per hour, without that well-known noise, accompanied with great agitation in the flame, called "roaring" or "blowing." Even at that consumption, and below, the flames flickered a great deal, and there seemed no intermediate stage between the flickering, which is frequently seen when jets of a high gauge burn small quantities of gas at low pressures, and the roaring or blowing which occurs when the gas issues at too great a velocity for the jet to form a properly shaped flame, which shall draw in regularly the required amount of air.

### *Experiments on "Carburetted" gas.*

Object of a gas carburettor.

The object of the "carburettor" is to add to common gas, after it has passed the house meter, a vapour rich in carbon and of nearly the same chemical composition as the highly illuminating carburetted hydrogen, much of which is destroyed by the high heat which is usually given to the gas retorts. The common practice of "firing" good gas coal at a high temperature increases, by about 25 per cent., the amount of gas evolved at low heats, but it decreases the illuminating power about 20 per cent. While companies sell their gas by quantity and not by the actual amount of light supplied they will naturally continue to obtain as large an amount of gas as possible provided they just keep it up to the standards required by their acts. Of course there may be other reasons inducing companies to increase the illuminating power of the gas supplied, but it seems to be a rule that the consumer, to obtain a given amount of light, is compelled to use as large a quantity of gas as possible.

The liquid used in the carburettor is the most volatile of the liquids obtained in the manufacture of paraffin oil, and known in commerce under the name of naphtha. It is sufficiently volatile to be taken up in such quantities as to render a poor gas highly illuminating.

Carburettors were sent to the Testing House by Mr. Bower of St. Neots, Hunts, and by Mr. G. Glover of Ranelagh Road, Pimlico, London.

Bower's carburettor.

That sent by Mr. Bower is large enough for from five to eight lights. After the gas has passed the ordinary house meter it enters the inlet pipe of the carburettor, and thence

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passes to the chamber where it is exposed to a very large surface of the naphtha suspended in wool. Here it takes up the required amount of vapour, and then passes to the outlet pipe which is connected with the gas pipes of the house. There is a tap on the top of the instrument by which the amount of carburetting can be regulated. The same maker also exhibited a street lamp carburettor upon the same principle. The top of the lamp-post forms the chamber for the oil. The whole arrangement is very neat and well adapted to its purpose.

The great advantage in Mr. Bower's carburettors is their simplicity of construction, they cannot get out of order.

Glover's carburettor.

In the carburettor of Mr. George Glover, provision is made against the difficulty of obtaining naphtha having a uniform boiling point. The volatility of most of the naphtha of commerce is very much less after a certain portion has been taken up by the gas, hence, after an ordinary carburettor has been at work for some time, the illuminating power of the gas from it is much lower than at the commencement. This instrument has two chambers, the upper, a reservoir for the oil, the lower, for carburetting the gas. The top supplies the bottom after the principle of the "bird fountain," so no oil passes from the top, till that in the bottom has been reduced to a certain level. If however, the top chamber is not perfectly air tight, the oil fills the bottom and no gas can pass. This seems a point on which great attention should be bestowed, or some trouble will be occasioned by the total stoppage of gas. The bottom chamber contains spirals filled with sponge and in these the gas is exposed to the naphtha.

The details of the internal parts of the carburettors of both makers are well adapted for charging the gas with a large quantity of vapour. It was found in each case that gas could be supplied to the number of jets for which the instrument was constructed of a higher illuminating power than could be consumed by the ordinary burners.

The results in table I. were obtained by the use of Mr. Glover's carburettor, which was fitted with an arrangement which permitted gas to be brought to any required illuminating power.

The consumption of five cubic feet per hour, and illuminating power of from 12 to 15 candles, were taken as being about what would be required in ordinary use.

TABLE I.

Five cubic Feet of Gas consumed per Hour in each case.

| Name of Burner. | Illuminating Power to which the Gas was brought by the Carburetter. | Consumption of Naphtha per Hour. | Cost of 1,000 cubic Feet of Gas with the Naphtha used. — Gas taken at 4*s.* per 1,000, Naphtha at 3*s.* per Gallon. | Cost of an Amount of Gas necessary to give the same Light as 1,000 Feet of Carburetted Gas. |
|---|---|---|---|---|
| | Candles. | Grains. | *s.* *d.* | *s.* *d.* |
| Batswing burner of Paris street lamps - | 12·5 | 35· | 4 $4\frac{3}{4}$ | 4 $5\frac{1}{2}$ |
| Leoni's, No. 6. batswing | 12·5 | 51·7 | 4 7 | 4 $9\frac{1}{2}$ |
| Sugg's argand for 14-candle gas - - - | 15·5 | 73·5 | 4 10 | 4 $6\frac{1}{4}$ |
| Sugg's argand for 16-candle gas - - | 15·5 | 105· | 5 $2\frac{1}{4}$ | 4 $6\frac{1}{2}$ |
| Sugg's argand for 18-candle gas - - | 15·5 | 160· | 6 10 | 4 $9\frac{1}{2}$ |
| G. Glover & Co's. special burner for carburetted gas - - - | 28·6 | 444·5 | 9 $0\frac{3}{4}$ | 8 $6\frac{1}{2}$ |

Cost of using gas carburettor.

As regards cost, these results show with one exception an advantage in using an increased quantity of common gas instead of the carburetted gas. Thus the Paris street lamp burner, consuming five cubic feet per hour of Paris gas, gives a light equal to 10·9 candles, calculating gas at 4*s.* per 1,000 cubic feet, and oil at 3*s.* per gallon, the total cost of 1,000 cubic feet of carburetted gas, to give 12·5 candle power, at the same consumption, is 4*s.* $4\frac{3}{4}d.$, while the cost of gas alone to give the same amount of light is 4*s.* $5\frac{1}{2}d.$, showing an advantage of $\frac{3}{4}d.$ per 1,000 cubic feet in favour of the carburettor. In all other results the advantage is on the side of an increased quantity of gas.

Sufficient has been given in this table to enable one to calculate the relative costs in the two cases whatever may be the prices of the gas and oil. Thus, suppose the price of gas is 5*s.* per 1,000 cubic feet, and oil 2*s.* per gallon, taking the result from Sugg's 16-candle argand, we have:—

Cost of increased light as obtained from naphtha = $\frac{2}{3}$ of 1*s.* $2\frac{1}{4}d.$ = $9\frac{1}{2}d.$

Cost of increased light as obtained from gas = $\frac{5}{4}$ of $6\frac{1}{2}d.$ = $7\frac{1}{2}d.$

still showing a result in favour of gas.

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These results apply only to 12½ candle gas, but they seem to prove that in ordinary circumstances there is no advantage in using the carburettor except suitable oil can be obtained at a trifling cost, or the gas is both very poor and very dear.

TABLE II.

No. 4 Batswing Burner, consuming 5 cubic Feet per Hour.

| Series of Experiments. | Consumption of Gas in cubic Feet. | Consumption of Naphtha in Grains. | Average Illuminating Power. | Illuminating Power of best Batswing Burner without Carburetting. | Increase due to Naphtha. | Grains of Oil per cubic Foot for each Candle Power of increased Light. |
|---|---|---|---|---|---|---|
| 1 | 97·4 | 6,006 | 24·3 | 10·9 | 13·4 | 4·6 |
| 2 | 48· | 1,262 | 16·2 | 10·9 | 5·5 | 4·7 |
| 3 | 45· | 816 | 15·0 | 10·9 | 4·1 | 4·4 |
| 4 | 106·3 | 1,186 | 13·7 | 10·9 | 2·8 | 3·96 |
| | | | From Table I. | Paris street lamp burner | | 4·1 |
| | | | | Sugg's 14-candle argand | | 4·9 |
| | | | | „ 16 „ „ | | 7·0 |
| | | | | „ 18 „ „ | | 10·6 |
| | | | | Glover's special burner - | | 5·5 |

The results of Table II. were obtained from the carburettor of Mr. Bower. The gas was regulated to five cubic feet per hour, as nearly as possible, and the amount of carburetting so arranged as to give approximately the desired illuminating power.

The register of the meter and the weight of the carburettor having been taken, the gas was lighted and allowed to continue burning for about nine hours, in each of two experiments, and about 20 hours each in the others. At intervals during these periods, the meter was adjusted, and the illuminating power of the flame taken. The results given are the averages.

From the last column it appears that the amount of naphtha consumed per foot of gas, for each candle power of increased light, depends more upon the burner than upon the extent to which the gas is carburetted. There appears to be no advantage, as regards the light obtained from a given weight of oil, in increasing the consumption, as is the case with gas.

From calculation, taking the above prices of gas and naphtha, it would appear that if less than 5·6 grains of oil were consumed per cubic foot for each candle power of increase in light there would be an economy in using the carburettor; but it must be remembered that the illuminating power of a flame increases much more rapidly than the

increase in consumption; eight cubic feet per hour, burned in proper argands, gives double the light of five cubic feet; so if the light be brought up to 25 candle power by the carburettor, less than 3·36 grains should be consumed per foot for each candle power of increased light. But this number is much below any result obtained.

*Experiments on Scholl's Patent Platinum Light Perfecters.*

These perfecters, manufactured by Mr. Scholl of 41, Berwick St., Oxford St., London, are little rings of brass carrying a small plate of platinum about four-tenths of an inch long, by 1½-tenths wide. The rings fit on the top of either fishtail or batswing burners, and support the platinum in a vertical position so that the gas as it issues from the burner is divided into two parts in the direction of the flat surface of the flame. They appear best adapted for fishtail burners. With these the two jets of gas, instead of impinging one on the other, impinge on the two sides of the platinum and unite above to form the flame. The increase of light is very striking when the perfecter is placed on a jet of small bore, supplying gas at a high pressure. The effect, however, decreases as the pressure decreases, or what is equivalent, as the gauge of the openings increases. This gives an explanation of the action of the perfecter. The gas impinging on the sides of the piece of platinum, loses part of its velocity, and consequently the amount of air drawn into the flame by the jet is lessened.

The following table shows the increase of illuminating power due to the perfecter when used on burners of various gauges:—

| Kind of Burner. | Cubic Feet of Gas per Hour. | Pressure in Inches. | Illuminating Power. Without Perfecter. | Illuminating Power. With Perfecter. | Increase per cent. | Remarks. |
|---|---|---|---|---|---|---|
| Leoni's No. 2, fishtail | 3 | 0·84 | 1·3 | 4·1 | 215 | |
| „ No. 3, „ | 3 | 0·46 | 2·4 | 4·6 | 91 | |
| | 4 | 0·7 | 2·8 | 6·5 | 132 | |
| „ No. 4, „ | 3 | 0·31 | 3·4 | 5·0 | 47 | |
| | 4 | 0·47 | 4·5 | 7·6 | 68 | |
| | 5 | 0·71 | 5·0 | 9·2 | 84 | |
| „ No. 5, „ | 4 | 0·42 | 5·3 | 6·9 | 30 | |
| | 5 | 0·6 | 6·1 | 8·3 | 36 | |
| | 6 | 0·81 | 7·1 | 10·0 | 40 | Flame flickers. |
| „ No. 6, „ | 4 | 0·31 | 6·2 | 8·0 | 29 | „ „ |
| | 5 | 0·46 | 8·0 | 10·4 | 30 | Flame flickers a great deal. |

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The flames from the No. 6. burner with the perfecters flickered too much for ordinary use when consuming five cubic feet per hour. With burners above this gauge this flickering increased, in fact the perfecters narrowed and heightened the flame just as an increase in the size of the holes of the burner would have done, and it appears that the increase of light due to the perfecter may be obtained by simply enlarging the size of the openings through which the gas issues. This size is limited by the flickering of the gas, for the jet must escape with sufficient velocity to give a proper form to the flame. The use of the perfecter is limited in the same manner, and it appears that no more light can be obtained from a given quantity of gas by the use of a perfecter than by the use of an ordinary burner of the proper shape and gauge of opening to suit the consumption and quality of the gas.

On comparing the results from fishtail burners with the results just given, it will be found that with consumption of five cubic feet of gas per hour, a No. 6 burner, with the perfecter, gives the same light as a No. 7 or No. 8 burner without the perfecter.

*Results of Experiments on Stoves for Heating Water by Gas.*

Method followed in testing.

These results were obtained by boiling a measured quantity of water in a tin kettle over the flames of the stove. Observations were made of the temperature of the water at the commencement, the amount of gas consumed, and the time from the application of the light to the boiling of the water.

In every case the apparatus was perfectly cold before starting. Care was taken to keep the room free from draughts, but otherwise the stoves remained just as in ordinary use.

In the experiments, the results of which appear in Table I. two litres of water were contained in a kettle of appropriate size and ordinary shape. In those of Table II. the kettle contained four and a half litres of water and had a much larger bottom in proportion to its size; it was one such as is used for boiling on the hot plates of cooking ranges.

In all cases the time and consumption of gas have been calculated for water at 15·5 Centigrade.

TABLE I.

| Name. | Time taken to boil 2 litres of Water at 15·5 Centigrade. | Amount of Gas consumed. | No. of Kettles of Water which can be boiled for 1 Penny with gas at 4*s.* per 1,000 cubic Feet. |
|---|---|---|---|
| | minutes. | litres. | |
| Schaeffer and Walcker (*a*) | 20· | 62·2 | 9· |
| „ „ (*b*) | 16·5 | 57·7 | 9·8 |
| Leotard's, both rings | 15· | 97·7 | 6·4 |
| „ centre ring | 20· | 64·0 | 8·7 |
| Phillips' atmospheric | 19· | 57·2 | 9·9 |
| Leoni's large | 11· | 68·2 | 8·3 |
| „ small | 15· | 60· | 9·4 |
| Bengel's (*a*) | 24· | 66·5 | 8·5 |
| „ (*b*) | 23· | 62·3 | 9· |
| „ (*c*) | 32· | 60·3 | 9·4 |

TABLE II.

| Name. | Time taken to boil 4½ litres at 15·5. | Amount of Gas consumed. | No. of Kettles of Water which can be boiled for 1 Penny with Gas at 4*s.* per 1,000 cubic Feet. |
|---|---|---|---|
| | minutes. | litres. | |
| Schaeffer and Walcker (*a*) | 37·5 | 127·3 | 4·4 |
| Phillips' rings | 27·5 | 215·1 | 2·6 |
| Leoni's large stove | 20·5 | 136· | 4·1 |
| „ „ at low pressure | 27· | 127·5 | 4·4 |
| Leotard's | 24·5 | 155·1 | 3·6 |

1,000 litres (1 cubic metre) of gas are 35·31 cubic feet.
Two litres of water are 3·52 pints.
Four and a half litres are 7·9 pints.
The average price and quality of London gas have been taken. In Paris the cost would be nearly double.

The "atmospheric burner" attached to Phillips' gas cooking apparatus consumed the least quantity of gas in boiling two litres of water, but the time taken was greater than that by some others. Messrs. Schaeffer and Walcker's (*b*) took 1 per cent. more gas, but 13 per cent. less time; hence the advantage between these two seems to lie with the latter. Again, the small stove of Mr. Leoni took about 5 per cent. more gas, but 21 per cent. less time, and his large stove about 20 per cent. more gas and 42 per cent. less time.

The saving of gas as against the saving of time may be looked at in this way: using Phillips's burner in preference to Leoni's large stove would effect a saving of one penny on

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50 kettles of water, whereas the time lost would be 6 hours 40 minutes.

Description of atmospheric burners.

*Description.*—These burners are all adapted for boiling water or vegetables, stewing and frying. They are all simply modifications of Bunsen's burner, in which a certain quantity of air is allowed to mix with the gas before it reaches the point at which it burns. If this amount of air be too great the mixture reaches the exploding point, and the flame runs down from the proper burner and burns at the point of exit of the gas within the tube which should carry the mixture of gas and air. This is the great objection to the use of the ordinary Bunsen's burner, in which this tube is vertical. If, for instance, one wishes to boil a vessel of water quickly, and afterwards allow it to simmer, he will first of all turn on a full supply of gas, and then turn it down very low; but the apparatus having become hot the upward current will give more air than ought to be mixed with the gas, consequently the flame will run down as before described, and not only give off very bad fumes and smoke, but perhaps dangerously heat the whole apparatus.

This difficulty is got over by many makers by arranging horizontally the tubes for carrying the gas and the mixture of air and gas. By this arrangement the air is drawn in solely by the jet of gas issuing into a horizontal tube opened at both ends, just as buildings are ventilated by compressed air. The amount of air mixing with the gas will be in proportion to the amount of gas discharged; so if the apparatus is arranged for admitting the required amount of air at a given consumption the proper quantity, or very nearly so, will be drawn in at any other rate.

*Schaeffer and Walcker, Berlin.*—The stove of this maker, marked (*a*) is an ordinary arrangement of three upright Bunsen's burners fitted to a heavy stand with a support for any vessel at the top. This is subjected to the disadvantage spoken of above.

That marked (*b*) has the horizontal arrangement of the pipes for carrying the gas and mixture of gas and air. This latter pipe discharges itself into a hollow *chamber* circular in its horizontal, and elliptical (flat) in its vertical section. On the upper part of this burner are a number of holes about three millimetres, or one-eighth of an inch in diameter. At these holes the gas burns. The burner is carried on a common circular support with four short legs. The total height of the stove is not more than 4½ inches.

The largest sizes of these stoves need not be constructed more than four inches high. This is an undoubted advantage over the others in point of stability.

Many experiments were made to try if the flame would run down and burn within the tube; but with the smallest amount of gas the flame remained at the burner, while with the largest amount the flame did not become yellow from a lack of air.

*M. Leotard's, Paris.*—This is also a horizontal arrangement. It differs from the above in having two horizontal pipes, each independent of the other, and having its own stopcock. One of these supplies an inner ring, and the other two outer rings of holes in the burner. This arrangement gives either a large ring of flames, as required for frying, &c., or a smaller one, as for keeping up a gentle heat under a stewpan.

The height of this stove is not more than four inches. The results obtained from it were not so good as those from Schæffer and Walcker's. It appeared that this particular one did not admit a sufficient supply of air.

*Phillips' "Atmospheric Burners."*—These formed part of a very complete little stove* for roasting, baking, boiling, &c. which has been reported on under "Cooking Apparatus." They are the ordinary Bunsen's burners, modified both at the inlet for the air and at the top where the gas burns.

*Leoni's, St. Paul's Street, New North Road, London.*—These stoves are made in two parts, a bottom chamber for regulating the admission of the air, and an upper where the air and gas is mixed. The gas is discharged into the bottom of the latter, which is a hollow vertical cylinder seven inches long and of about one inch in internal diameter. This cylinder expands at the top into a kind of funnel of four inches diameter closed by a disc having in it three holes of three-quarters of an inch diameter. These holes are fitted with little hollow cylinders of Leoni's patent Adamas, about half an inch high and half an inch in internal diameter. These form three burners for the mixture of air and gas, and being bad conductors of heat the body of the stove remains quite cool.

*Bengel's Burners* are the ordinary Bunsen's burners fitted at the top with a hollow disc of brass, from the edge of which the gas burns in a continuous ring. Some have also two slits at right angles across the top giving two lines of flame. They were arranged for chemical, and not for domestic purposes.

In Table II. the results of experiments on another part of Phillips' stove are given. This was constructed of ordinary

* The whole apparatus for cooking purposes is elsewhere reported on.

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rings of iron tubing pierced with little holes, and no air was mixed with the gas before combustion. The results show how much is gained in heating power by mixing air with gas, but it must be stated that this part of the stove is specially made for frying under the rings, as well as for boiling water above.

*Captain Donnelly's Arrangement for Lighting Fires without Wood or Paper.*

Description.

This consists of two Bunsen's burners, one attached to each side of the grate. The pipes carrying them are jointed to admit of the flames being concentrated on any point and in any direction. To light a fire the coal is laid in the ordinary way, and the flames allowed to play upon it in the centre of the grate. When the coal is fairly lighted the gas is turned off, and the burners turned back out of the way. Such an arrangement necessitates a pair of burners to each grate; but another arrangement exhibited is supported on a small moveable stand, the gas being supplied by a flexible tube, which can be attached to a cock at any convenient place near the grate, and removed after use. Thus one pair of burners serves for a whole house. The following are the average results of several experiments. In every case the fire was burning brightly when the flame was removed.

Results of experiments.

| Time taken. | Consumption of Gas. | Number of Fires which can be lighted for 1*d.*, taking ordinary Gas at 4*s.* per 1,000. |
|---|---|---|
| 11 minutes - | 2·64 cubic feet. | 8 nearly. |

*Experiments on Lamps, Candles, &c.**

Method of carrying on experiments.

These experiments were conducted on a Bunsen's photometer lent by Mr. G. Glover. At one end the standard candle was carried in a socket above one of the arms of the beam of an accurate balance, so that weighings could be made without removal. At the other end the lamp was counterpoised on a balance which turned readily with a weight of two grains when carrying four pounds.

After the lamp and the candle had been burning about half an hour the lamp was set as nearly as possible to the required candle power; both were then counterpoised, and the illuminating power of the lamp taken at regular intervals. At the end of an hour the amounts consumed were ascer-

* For preliminary remarks and diagrams of lamps, *vide* Report on Class 24.

tained, and the consumption of the lamp calculated for the illuminating power at which it had been intended that it should have burned. Each result given in the table is the average of two or three hours' observations.

TABLE I.—PARAFFIN LAMPS.—The same oil throughout.

| Name. | Illuminating Power at which the Lamp was set. | Grains of Oil per Hour. | No. of Hours' Light for 1*d.* taking Oil at 2*s.* 6*d.* per Gallon. |
|---|---|---|---|
| Young's (No. 5) | 4· | 227 | 8·7 |
| Stobwasser's (flat wick) | 4·5 | 385 | 5·1 |
| Rowath's (small lamp) | 5· | 280 | 7·0 |
| Marmet's (small round wick) | | 290 | 6·8 |
| „ (flat wick) | | 300 | 6·6 |
| Young's (flat wick) | | 310 | 6·4 |
| Ives' (large lamp) | | 310 | 6·4 |
| Young's (smaller flat wick) | | 314 | 6·3 |
| „ (another size) | | 316 | 6·3 |
| Rowatt's (large lamp) | | 317 | 6·3 |
| Sullivan's (Aladdin) | 6· | 336 | 5·9 |
| Stobwasser's (small round) | | 353 | 5·6 |
| „ (large round) | | 400 | 4·9 |
| Marmet's (disc above wick) | | 407 | 4·9 |
| „ (disc taken off) | | 413 | 4·8 |
| „ (disc changed in height) | | 439 | 4·5 |
| Brown and King's (disc above wick) | | 504 | 3·9 |
| Sullivan's (disc above wick) | | 568 | 3·5 |
| Young's (round) | | 381 | 5·2 |
| Rowatt's (large) | 8· | 384 | 5·2 |
| Young's (flat) | | 400 | 4·9 |
| Stobwasser's (small round) | | 491 | 4·1 |
| Ives' (large) | 9· | 439 | 4·5 |
| Marmet's (large disc above wick removed) | | 480 | 4·1 |
| Young's (large round) | | 491 | 4·0 |
| Sullivan's (Aladdin) | | 504 | 3·9 |
| Stobwasser's (large round) | 10· | 517 | 3·8 |
| Marmet's (disc lamp) | | 607 | 3·2 |
| Sullivan's (disc lamp) | | 723 | 2·7 |
| Marmet's (without disc) | 14·5 | 607 | 3·2 |

TABLE II.—PARAFFIN OIL LAMPS, with maker's own oil.

| Name. | Consumption per Hour per Candle Power.* | Retail Price of Oil taken for the next column of figures. | No. Hours' Light of 1 Candle Power for 1*d.* |
|---|---|---|---|
| | grs. | *s. d.* | |
| Sullivan's, with "Dimantine" | 57·6 | — | — |
| Young's, with paraffin oil | 54·9 | 2 6 per gal. | 35·8 |
| Brown and King's, with "burning liquid." | 61·6 | 6 0 „ | 14·2 |

* Average at 6, 8, and 10 candle power.

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## Experiments on Candles.

| Name. | Consumption per Hour in Grains. | Illuminating Power calculated for a Consumption of 120 Grains per Hour. | Retail price per lb. |
|---|---|---|---|
| | | | *s.* *d.* |
| Wilkie and Soames' "stearaffin" - | 123·4 | 1·15 | 1 0 |
| Wilkie and Soames' "Greenwich sperm." | 134· | 1·13 | — |
| Young's hard paraffin - - - | 110· | 1·1 | 1 3 |
| Field's paraffin - - - | 120·5 | 1·1 | 1 3 (?) |
| Young's hard paraffin, another quality | 111·6 | 1·09 | 1 3 |
| Wilkie and Soames' "stearaffin," another quality. | 138· | 1·05 | ? |
| M. Weiss' (Lyon) stearic, large - | 141· | ·79 | 1 0 |
| „ „ small - | 117· | ·68 | 1 0 |

This table contains trials of all the candles which exhibitors would give for the purpose. In most cases the request for specimens was refused.

## Table III.—General Table showing the comparative costs of Illuminating by Gas, Oils, and Candles.

| Substances, and how burned. | Prices taken for Calculation. | Number of Hours of Light obtained for 1*d.* per Candle Power. |
|---|---|---|
| Gas, burned from a proper argand burner, averages at 10, 12, and 14 candle power. | 4*s.* per 1,000 cubic feet of 12·5 - candle gas. | 51·6 |
| Gas, burned from the best batswing burners, averages at 6, 8, 10, and 12 candle power. | „ „ | 44·6 |
| Gas, burned from the best fishtail burners, averages at 6, 8, 10, and 12 candle power. | „ „ | 43·3 |
| Paraffin oil, averages at 6, 8, and 10 candle power, burned in an ordinary lamp. | 2*s.* 6*d.* per gal. | 38·4 |
| Colza oil, burned in a moderator at 9·6 candle power. | 4*s.* 6*d.* „ | 17·5 |
| Colza oil, burned without a chimney with a common flat wick. | „ „ | 11·5 |
| Paraffin candles, Young's - - - | 1*s.* 3*d.* per lb. | 4·26 |
| „ „ Field's - - - | „ „ | 4·26 |
| Stearaffin candles, Wilkie and Soames' - | 1*s.* „ | 5·65 |
| Stearine candles, French manufacture (Weiss, Lyon). | „ „ | 3·3 |
| Sperm candles, (those used for standard) - | 1*s.* 6*d.*(?) „ | 3·24 |
| "Dimantine" oil, Sullivan's - - - | — | — |
| "Burning liquid," Brown and King's - | 6*s.* per lb. - | 14·2 |

*Ironing Stove, invented and manufactured by H. C. Lacroisade, Paris.*

Stove for heating irons.

The fireplace of these stoves is a hollow hexagonal prism having its axis vertical. Bars at the bottom support the fuel and admit air for combustion. The top is closed by a cover, through the centre of which the products of combustion pass to a vertical pipe which enters the chimney or flue as convenient. About one foot of the bottom of this pipe is of the same casting as the cover, and fits to the remaining part of the pipe by a telescope joint which permits the cover being raised for charging the fire. The size of the fireplace is so regulated that there is room on each of its six exterior faces for an iron of the size for which the stove is made. A second hexagonal case encloses the former, leaving between the two a space equal to the thickness of the foot of the iron. Six ribs at the angles divide this space into six chambers, which are closed at the bottom; a flap closes the top of each. The irons used with this stove have their handles attached only to the heels of the feet, so that the irons may be put point downwards into the chambers above mentioned. A notch in the outside case receives the handle and permits the flap to close the chamber, so that no heat may be lost by radiation from the iron.

The following results were obtained from a stove which heated six irons, each of about four pounds weight, but much flatter than those in ordinary use.

Results of trial.

The stove was lighted by placing in the bottom a few shavings, then about 12 pieces of charcoal of the size of walnuts, and coke of the same size above.

The results are the averages of two series of experiments.

| | |
|---|---|
| Time from first lighting till six irons were fit for use | 25 minutes. |
| Time taken to heat a cold iron after heat had been got up | 4 „ |
| Time taken to reheat iron when too cold for use | 1·5 „ |
| Amount of coke expended to heat the first set of six irons | 1·3 lbs. |
| Amount of coke required per hour to keep six irons in constant use, six being used while six were reheating | ·88 lb. |
| Taking coke at 20*s.* per ton, cost per day of ten hours | about 1*d.* |

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## Experiments with Wavish's* Ships' Lamps for Burning Paraffin Oil.

### I.—*Steamers' Masthead Lamps.*

The lamp experimented on was not touched after having been put into the photometer. The case and reflectors were removed.

| Time of Observation. | Illuminating Power. | Consumption of Oil up to Time of Observation. |
|---|---|---|
| Lighted 6th June at 9.30 a.m. | 8·6 | —— |
| „ 10.0 a.m. | 9·7 | —— |
| „ 11.30 a.m. | 9·7 | 877 grains. |
| „ 12.30 p.m. | 9·2 | 1324 „ |
| „ 2.30 p.m. | 7·6 | 2233 „ |
| „ 4.30 p.m. | 6·5 | 3110 „ |
| June 7th at 9.30 p.m. | 2·2 | 8701 „ |

Trial for distance and time; not trimmed after lighted.

The same lamp was fixed on the lighthouse in the Champ de Mars, 176 feet above the ground, at 8 p.m. 3rd June. On the same evening at 8·45 and again at 9·45 it appeared quite bright when seen from a distance of 8·5 kilometres (5·28 miles). It remained untouched till the following evening when it was still distinctly visible from the same place at 9.10 and 10 p.m., that is 25 hours after the first observation. The evenings were moderately clear but not of average clearness for this time of year. On the next morning (5th June) at 9 a.m. it was still burning and giving a light of 1·5 candle power.

### II.—*Ships' Anchor Lamps.*

Lamp lighted at 10 a.m. At 10.45 it gave an illuminating power of 6·5 candles.

Trial in wind.

It was then suspended about 20 feet high in the open air in a rather strong wind till 1.45 p.m., when it had consumed (from 10.45) 1,062 grains of oil, or 531 per hour, and still gave a light of 6·5 candle power. It was then again suspended by a string about 12 feet long and by means of a cord attached to its bottom swung for one hour through an arc of from 100° to 120°, with frequent sharp jerks when in full swing. It was then taken down and found to have con-

Trial in motion.

* For remarks on and diagram of this lamp, *vide* Report on Class 24.

sumed 401 grains of oil during the hour. Its illuminating power was 6 candles. The top of the chimney was slightly blackened, but not near the flame.



Munn's Ships' Lamps consuming Oil or Candles.

*Lamp with 3 Flat Wicks, consuming Colza Oil.*

| Time. | Illuminating Power. | Consumption of Oil. |
|---|---|---|
| After burning 1 hour - - | 4· | 410 grains. |
| „ 2 hours - - | 4· | |
| „ 3 hours - - | 3·75 | 1226 „ |
| „ 6 hours - - | 1·1 | |
| „ 8 hours - - | 0·5 | 2500 „ |

There is some doubt whether this lamp was supplied with proper oil, although it was filled and trimmed by the maker's own attendant. Probably it should have burned much longer without any great diminution in illuminating power.

The same lamp burning a candle instead of oil gave the following results:—

Illuminating power of candle = 1·3 candles.
Consumption per hour = 161·7 grains.

so a candle of four to the pound would burn about 10 hours 50 minutes.

Considerable trouble was taken to obtain an authorized specimen of the ship's lamp used by the French navy for the purpose of testing it in comparison with Munn's, Wavish's, and the Trinity House lamp, but without success, the Minister of Marine refusing to lend his assistance. It remains therefore still for these lamps to be tested together by means of a telescopic photometer; the results, however, seem sufficient to show that the Wavish lamps will be found to give double the light at about one-half the cost of the ordinary ship's lamp.

Experiments on a Bath exhibited by Phillips, of Skinner St., London.

Description of peculiarities claimed.

The only specialty about this bath is the arrangement for heating the water.

This consists of an upright heating chamber divided by a number of concentric cylinders into several compartments in such a way that the heating surface is very large. The top and bottom of this chamber are on the same level as the upper and lower surfaces of the water in the bath. Two

Capt. Webber and Mr. Rowden on Testing House.

horizontal pipes, one at the top and the other at the bottom level, form a connexion between the water in the bath and that in the heating chamber. Gas, burned from a ring burner, is the source of heat. When the gas is lighted a circulation is started, the cold water entering the bottom of the boiler from the bath, and the hot escaping from the top to the bath. In this way the whole of the water in the bath is heated to the required degree. The whole arrangement occupies very little room, the boiler being close to the bath, and not one foot in diameter. Nothing but a gas pipe is required for arranging it in any room, but it appears very desirable that a small flue should be added to carry the products of the combustion of the gas into a chimney.

Suggested alterations.

Another point deserving the notice of the maker is the undue heating of the upper surface of the water in the bath while the bottom remains quite cold. This seems caused by an insufficient circulation, which is due partly to the smallness of the connecting pipes and partly to the way in which these pipes are attached to the boiler. The construction of the boiler would impede the circulation if the sections shown were correct, of which there is a doubt.

Results of trials.

The bath worked very well, with no more trouble than turning a tap for the supply of water and then applying a match to the gas. The following results are the mean of three experiments. The bath had not the cover which is usually supplied so more loss by radiation and evaporation occurred in these experiments than in actual use.

| | |
|---|---|
| Amount of water in the bath | = 50 gallons. |
| Time taken to raise the temperature 4° Fahr. | = 5 minutes. |
| Consumption of gas for each 4° increase of temperature | = 4·5 cubic feet. |

Thus, suppose the water to be at 60° Fahrenheit and a bath at 80° is required, the time necessary to heat the bath will be 25 minutes, with an expenditure 22·5 cubic feet of gas, costing (at 4*s.* per 1,000 feet) 1·08 pence.

REPORT on ARTILLERY.—By Lieut-Colonel C. H. OWEN, R.A., Professor of Artillery, R. M. Academy, Woolwich. LIEUT.-COL. OWEN ON ARTILLERY.

IN the Great Exhibition of 1851, the display of military weapons was small, and again in the Paris Exhibition of 1855 the same deficiency was observed, the French and Belgian Governments being almost the only exhibitors of ordnance. In the London Exhibition of 1862 artillery *matériel* was however fully represented, showing that much attention had been given in the interval between this and the last Exhibition to the manufacture of ordnance. The development of this and other branches of military manufactures was doubtless owing in a great measure to the Crimean War, which gave a rude shock to the prevailing idea of the future peaceful career of the world's progress, and, proving that disputes would still be sometimes decided by force of arms, showed clearly that the cultivation of the military arts could not be neglected with impunity. Recent development of military manufactures.

It is only in actual warfare that the practical excellence of new weapons can be satisfactorily tested, and in times of peace there is little inducement for private enterprise to engage in military manufactures, the Government arsenals being fully competent to provide the guns and stores required for the service. During the last few years, however, so many gigantic struggles have rapidly succeeded each other, all clearly demonstrating the advantages secured by superior armaments, that much private capital and ingenuity have found ample employment, both in this country and abroad, in all branches of military manufactures.

For some time previous to the Crimean War but little interest was taken in military questions; nevertheless, several important improvements in arms had been introduced during the long European peace, especially in the few years preceding the Great Exhibition. The adoption of shell-guns, and the consequent development of horizontal shell-fire—the destructive effects of which were so clearly pointed out by General Paixhans, and practically demonstrated at Sinope and Sebastopol—was a most important advance in the science of attack, and eventually led to the adoption of iron armour as a protection to vessels of war. The advantages of rifling, and the substitution of elongated for spherical projectiles, had been proposed in the middle of the last century by the celebrated Benjamin Robins; but, although rifled muskets have now been long in use, elongated projectiles were only

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adopted, for the first time (by the French), about five years previous to the Great Exhibition. Two years later the Prussians introduced the needle gun, which has lately become so famous; and about this time the question of rifled ordnance assumed a practical shape, rifled breech-loading guns being proposed by Major Cavalli, of the Sardinian artillery, and by Baron Warendorff, a Swedish nobleman, and which were tried in England and abroad.

Gradual adoption of rifled ordnance.

It would, then, appear that military manufactures, although in a depressed state, had still been making some progress; and when the great European Powers determined upon the Crimean War, the weapons with which both land and naval forces were supplied were much superior to those used in the wars at the beginning of this century. The British Army was almost entirely armed with rifled muskets, and many of the French, Russian, and other troops had also a fair proportion of them. The artillery used on both sides, with the exception of a few Lancaster rifled guns belonging to the English, was composed of smooth-bored pieces of cast iron or bronze; but the calibres had been much increased since the Peninsular War, 8-inch and 32-pounders having taken the place of 24 and 18 pounders; and 10-inch and 68-pounders, then thought enormous pieces, having been procured from the fleets.

The first rifled ordnance employed in warfare were the 68-pounder, and 8-inch Lancaster guns used by the English at the siege of Sebastopol in 1854; these did not answer so well as was expected, and were subsequently withdrawn from the British Service, in consequence of the liability of the shot to jam in the bore and cause fracture of either gun or projectile, a defect since remedied. The second employment of rifled ordnance in the field was in the Italian Campaign of 1859, when the French, who had converted their smooth-bored bronze pieces into rifled guns, were said to have used them with considerable success against the Austrian troops at long ranges; the accounts of the actual performances of these guns were, however, somewhat conflicting.

In the great American struggle rifled ordnance were employed in large numbers on both sides, and the effects they produced at Charleston fully confirmed the predictions of their superiority over smooth-bored pieces for siege purposes. Again at Düppel, the fire of the Prussian rifled guns completely overpowered that of the antiquated smooth-bored pieces with which the Danish works were armed. Other instances might be cited to show the superiority of rifled over smooth-bored artillery, but it will be sufficient to point

out here, that all the great Powers have of late years endeavoured to perfect that system of rifling which has appeared to each to offer the greatest advantages.

In the British Service, the smaller nature of rifled guns are breech-loading with soft-coated projectiles, and the large pieces, muzzle-loading with button projectiles, the general opinion being also in favour of the latter system for small as well as large rifled ordnance. In France the smaller rifled guns are muzzle-loading with projectiles having studs or buttons, while the heavy are breech-loaders, with button projectiles. In Russia and Prussia, breech-loading with soft coated projectiles is employed for both light and heavy rifled guns. It may thus be noticed that there is at present much diversity of opinion among artillerists respecting the relative advantages and disadvantages of different systems of loading and rifling.

Systems of rifling.

It may be as well to explain, that most of the systems of rifling that have been adopted by any service, or tried on the practice ground, may be classed as follows:—

(1.) Muzzle or breech-loading guns having projectiles of iron, fitting the peculiar form of the bore mechanically.

(2.) Muzzle or breech-loading guns, with projectiles having soft metal studs or ribs, to fit the grooves.

(3.) Muzzle-loading guns with projectiles, having a soft metal envelope or coating, which is expanded by the gas in the bore.

(4.) Breech-loading guns with projectiles having a soft metal coating larger in diameter than the bore, but which is compressed by the gas into the form of the bore.

The Whitworth is a type of the 1st class; the Woolwich, French, Dutch, and Spanish of the 2nd; the Ferris of the 3rd; the Armstrong and Prussian of the 4th; the Austrian being a compromise between the 2nd and 4th.

The respective advantages offered by these classes may be briefly stated thus:—1st class; simplicity, economy, and durability of projectile. 2nd class; the studs being soft, the bore not liable to injury from the shot, and if a jam should occur, they will give way and thus prevent fracture of gun or projectile, also that a gaining twist may be employed. 4th class; steadiness of axis of projectile, and non-liability of bore to injury from shot or powder gas, and adaptability to a gaining twist. The 3rd class possesses the same advantages as the 4th, but it has been found that projectiles with expanding coatings, although giving good results with low charges, will not stand high charges. The chief objections

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to the different systems are:—To the 1st: that both projectile and bore being hard fracture may not unfrequently occur, in case of a shot jamming, and that a gaining twist cannot be used. To the 2nd: that the projectiles are more expensive and the studs are liable to injury in storage, which latter can, however, be prevented for all ordinary cases by slightly hardening the studs. To both these classes: damage to the bore by scoring caused by rush of gas over shot; but it has been shown by experiment that this can be prevented by the use of wads. To 3rd and 4th class: expense and liability to injury of projectiles, and increased strain from a given charge.

Much confusion of idea prevails as to the meaning of the term "system of rifling," as applied to guns, inventors often claiming principles which are as applicable to one as another as parts of their systems. It may then be as well to point out, that the system of rifling consists essentially in the means of giving rotation to the projectile, but that the twist of the grooves, the length, diameter, or form of the projectile, must depend upon the purpose for which a gun is required, no matter upon what system it may be rifled. As regards precision of fire, one system will give as good results for all practical purposes as another, provided the conditions of charge, projectile, and twist of grooves are alike, and the rifling of the bore and the manufacture of the projectiles have been performed with the same amount of care and skill in both cases. By giving a *gaining twist* to the grooves the shot does not commence to rotate till it has moved some little distance, and the *initial strain* is decreased, a point of great importance.

Breech-loading and muzzle-loading.

Opinions being also divided as to the relative merits of breech and muzzle-loading ordnance, it may prove useful to state their respective advantages and disadvantages. The advantages of loading cannon at the breech are,—that the bore of the gun can be more easily cut than that of a muzzle-loading piece; that the projectile being larger than the bore, its axis will be stable; that the gun can be loaded when run up, the gunners being therefore less exposed; then the gun can be worked in a smaller space (than a muzzle-loading piece); the cleaning of the bore can be more readily effected, and any ignited substance left in the bore can be seen and removed; and that there is no danger of the shot not being home. It is, however, attended with the following disadvantages, viz., that the construction is more complicated than that of a muzzle-loading piece; that if a gun be of large calibre, the breech-loading apparatus, when sufficiently strong and heavy, will be unwieldy; that with the same weight of metal, the breech-

loading is a weaker and less enduring construction than the muzzle-loading.

On the other hand, a muzzle-loading gun has the great advantages of simplicity and strength, but the gun detachment is more exposed than with a breech-loading piece, and if loaded carelessly the shot may not be rammed *home*, in which case the metal of the gun may be fractured by the suddenly condensed gas. Now that ports or embrasures will be generally protected by iron and reduced in size, the gun detachment will be little exposed in any case.

Recent changes in materials and construction.

The difficulties attending the application of rifling to ordnance are very great, both as regards the efficient service and the necessary strength of a gun; and these difficulties have been much increased of late by the demand for ordnance of very large calibre to throw heavy projectiles with high velocities. The strain upon the metal in rifled guns being much greater in proportion to the weight of projectile and charge fired than in smooth-bored pieces, the charges of the former are less than those of the latter, being only from one-tenth to one-sixth the weight of the projectile, instead of one-fourth to one-third; and it must be remembered that as the calibre of a gun is increased, so greater difficulty is experienced in obtaining a sound construction. Other difficulties arise in the mounting of large pieces on suitable carriages and platforms, which must combine enormous strength with great facility of working; to obtain these, the strongest and soundest materials and additional mechanical appliances are required.

The recent changes in the materials employed for ordnance, carriages, and projectiles, as well as the increased size and weight of the guns and their appliances, may be observed in the present Exhibition. In 1862, with the exception of a Blakeley 200-pounder and the Alfred gun exhibited by the Mersey steel and Iron Company, no piece was shown for a projectile over 100 lb. in weight.* Several 9-in. guns, which fire shot of 250 lb., with a charge of 43 lb., are now exhibited; a 600-pounder and a 1000-pounder are also shown; but the latter has not yet been fired, and can therefore only be accepted at present as a specimen of manufacture. It will be noticed that wrought iron and steel have replaced to a great extent cast iron and bronze, although the two latter are still employed for smooth-bored guns, and bronze for rifled pieces of small calibre. There are a few cast-iron rifled guns strengthened with steel hoops. Wrought iron has

* A 110-pounder Armstrong gun was sent, but the projectile has since been reduced to less than 100 lb.

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taken the place of wood for many gun carriages; and steel or chilled iron has replaced cast-iron for projectiles for special purposes, such as the penetration of armour-plates.

## England.—War Office Exhibition.

Ordnance and carriages.

It is to be regretted that the British Government are again alone in sending a complete supply of munitions of war;* but, this being the case, it will be better to take the War Department annexe first, and give a brief description of its contents, which, it is generally acknowledged, reflect so much credit on the manufacturing departments of the Royal Arsenal at Woolwich, on the Ordnance Select Committee, and on others concerned in their production. Here everything has been admirably arranged,† the guns being mounted on their respective carriages, and platforms or slides, with ammunition and side-arms complete. Few visitors probably think of the time and labour that have been expended in placing all the different objects, especially the heavy guns and carriages, in the perfect order in which they now appear.

The following rifled guns are exhibited:—

Muzzle-loading.—12-in., on wrought-iron casemate carriage and platform; 9-in., on wrought-iron naval carriage and slide; 7-in., on wrought-iron naval carriage and slide; 64-pounder, on wooden ship carriage.

Breech-loading.—7-in., on casemate sliding-carriage and traversing-platform; 64-pounder (wedge) siege travelling-carriage; 40-pounder (screw), ditto; 12-pounder (screw) field-carriage; 9-pounder (screw) ditto. Wooden carriages.

Armstrong and Fraser constructions.

All the above guns are built upon the Armstrong method of construction except the muzzle-loading 64-pounder, the manufacture of which is a modification of the former. The essential features of the Armstrong method are:—

1. The disposal of the fibre of the metal round the bore by coiling, so as to resist the tangential strain, the welds running in the direction of least strain as regards their separation.

2. The employment of a breech-piece to support the bottom of the bore, with the fibre running lengthwise, so as to resist longitudinal strain.

3. The shrinking on the different portions, so that the exterior of the gun may take a due share of strain.

The inner barrels of the 12-in., 9-in., and 7-in. muzzle-loading guns are of tempered steel, with solid ends; these are

* The heavy French rifled guns were not sent till July.

† By Colonel Younghusband, R.A.

strengthened with wrought-iron coils shrunk on; the trunnion-ring, breech-piece, and cascable, which is screwed into the latter, are solid wrought-iron forgings. The different parts are hooked together by shoulders and corresponding recesses to prevent their separation.

The muzzle-loading 64-pounder is made on Mr. Fraser's cheap-construction plan, and consists simply of a coiled iron tube, of which the muzzle part is double, but with a triple coil over the breach, these with the trunnion-ring being welded together. By coiling bars one over another so as to form double or triple coils, and thus reducing the number of parts, and employing a cheaper iron for the outer portion, a considerable saving in time and expense is effected, the separation of the different parts being prevented by welding instead of by the tension of shrinkage and the use of projections and recesses, as in the 7-in., 9-in., and 12-in. guns. To illustrate the Fraser method of manufacture for heavy ordnance, an enormous unwelded triple coil, and a breech coil and trunnion piece forged hollow, welded together, and turned, both for a 25-ton gun, are shown.

Service rifled ordnance.

The following table gives the weights, &c., of the rifled guns:—

| | Gun. | Weight of Gun. | Length of Gun. | Rifling. | | Charges. | | Projectiles. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | No. of Grooves. | Twist. | Battering. | Service. | Weight. | Burst in Charge-shell. |
| | | Tons. | Inches. | | Cals. | lbs. | lbs. | lbs. | lbs. |
| Muzzle-loading. | 12-in. | 23 | 171 | 9 | 1 in 100 to 1 in 50 | 70 | .. | 600 | — |
| | 9-in. | 12 | 147 | 6 | 0 to 1 in 45 | 43 | 30 | 250 | 18 |
| | 7-in. | 6½ Cwt. | 125 | 3 | 1 in 35 | 22 | 14 | 115 | 8¼ |
| | 64-pr. | 64 | 111 | 3 | 1 in 40 | .. | 8 | 64 | 4½ |
| Breech-loading. | 7-in. | 82 | 120 | 76 | 1 in 37 | .. | 11 | 90 | 6½ |
| | 64-pr. | 61 | 110 | 70 | 1 in 40 | .. | 8 | 64 | 4½ |
| | 40-pr. | 35 | 121 | 56 | 1 in 36½ | .. | 5 | 40 | 2½ |
| | 12-pr. | 8 | 72 | 38 | 1 in 38 | .. | 1½ | 12 | ⅞ |
| | 9-pr. | 6 | 62 | 38 | 1 in 38 | .. | 1⅛ | 9 | ⅝ |

All these guns have preponderance, except the 12-in. and 9-in., which have none.

The 12-in., 9-in., and 7-in. guns are rifled on the Woolwich system, the grooves of the two first having an increasing twist, but those of the 7-in. a uniform twist. By using an increasing twist, the *initial strain* upon the gun is much reduced, the rotatory motion not being given when the shot is put in motion, but gradually acquired as it moves down the bore.

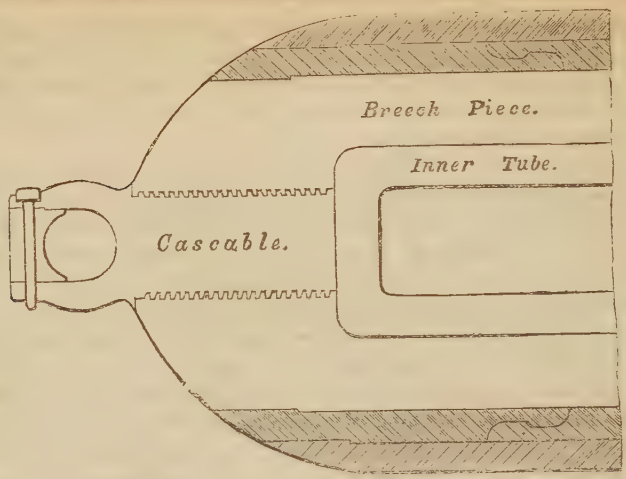



Fig. 1.—SECTION OF BREECH; BRITISH GUN (9-INCH).

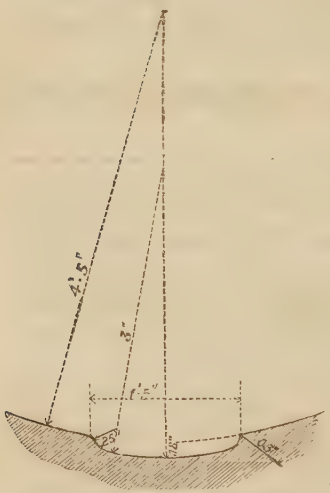



Fig. 2.—GROOVE OF BRITISH ML. R. GUN (9-IN.)

The projectiles have two rows of gun-metal studs to fit the grooves, the edges of which are rounded off, as seen in the section (fig. 2). Sharp angles in a groove are objectionable, as the gas enters them and causes fissures. The buttons of the 7-in. projectile are all of the same size; but the front studs of the 12-in. and 9-in. projectiles are smaller than the hind ones, to suit the constantly varying angle of the increasing twist.

The muzzle-loading 64-pounder is rifled on Sir W. Armstrong's *shunt* system. The depth of each groove on the *driving* side is decreased near the muzzle, an incline leading up from the bottom of the groove to the shallower portion. The groove is also very wide at the muzzle, but contracted at some distance down the bore, below the bottom of the incline. The studs, which are of copper, fit easily into the broad and deep part of the groove at the muzzle.

When a projectile passes down the bore of a rifled gun from the muzzle, its studs press against one side of the grooves; but on being forced out by the gas, they press against the other side. When the shunt gun is loaded, each

stud presses against the side, A B, of a groove, and so runs easily home, being shunted on its way down into the narrow portion of the groove, but on coming out again it presses against the (driving) side C D, and near the muzzle rises up the incline into the shallow part or on to the high level, and so is slightly compressed; the projectile, therefore, leaves the bore fitting tightly and with its axis stable, or is what is termed "centred," which is not, however, found to improve the shooting of the gun.

The breech-loading guns have all the same polygonal system of rifling, with lead-coated projectiles, the lead being attached by means of zinc. With these or similar projectiles, such as the Prussian, the bore of a gun is not scored by the rush of gas over the top of the shot, as is the case in rifled pieces having windage. The form of the groove is shown in fig. 6.

*Fig. 3.*

*Groove of Shunt Gun.*

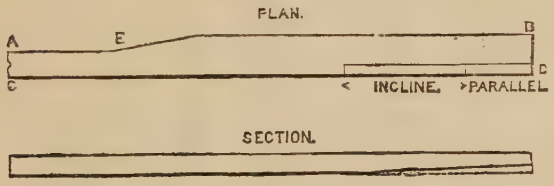


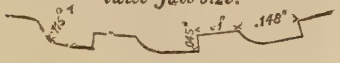

*Fig. 4*

*Fig 5.*

Fig. 6.

*Section of Grooves of 12 Pr.*

*twice full size.*




The screw breech-loading arrangement will be readily understood by reference to fig. 7. The breech-screw, which is tightened or released by the lever and tappet rings, secures the vent-piece, and thus closes the bore. The vent-piece is lifted out previous to loading, the projectile, lubricator, and charge being inserted from the rear through the breech-screw. The vent-piece, except in the 7-in. gun, is faced with copper, which fits against a copper ring in the bottom of the bore. The 7-inch gun is fired with a tin cup behind the cartridge, to prevent the escape of gas, the vent-piece having no copper

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face, but a wrought-iron ring being screwed into the bottom of the bore.

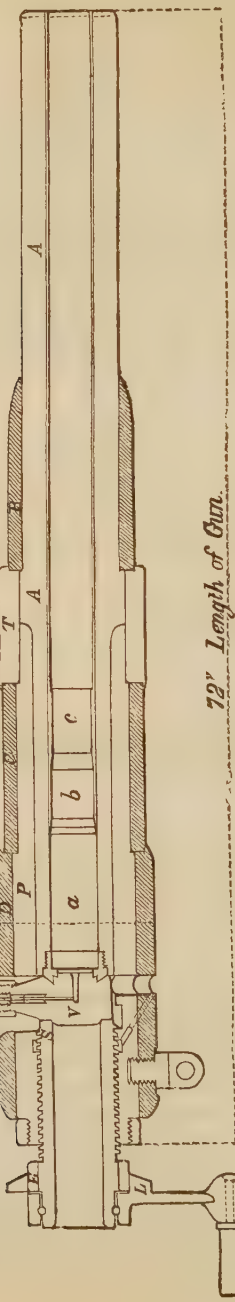



Fig. 7.—SCREW BREECH-LOADING ARRANGEMENT, BRITISH GUN (12 PR.)

A A. Barrel.
B C D. Coils.
P. Breech-piece.

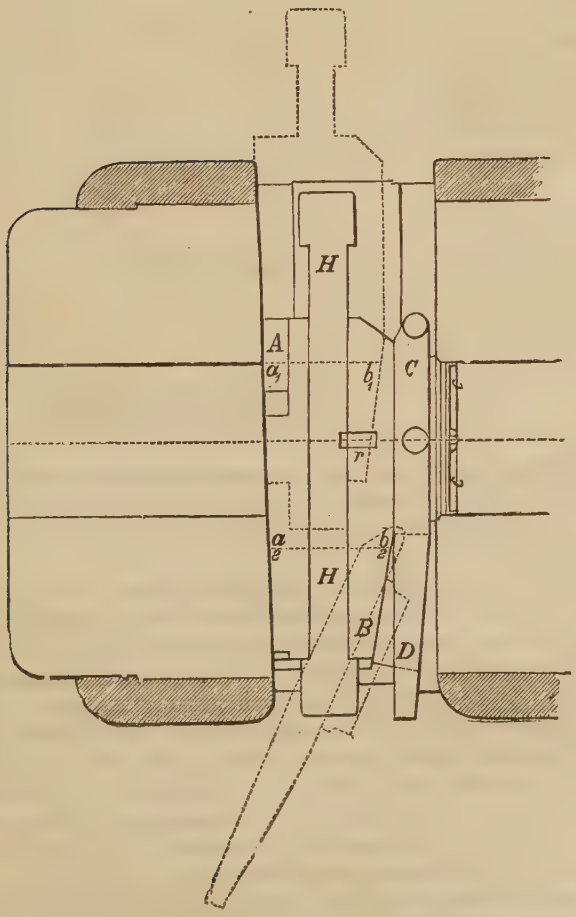
T. Trunnion ring.
V. Vent-piece.
E. Tappet ring.

L. Lever ring.
S. Breech-screw.

The wedge breech-loading arrangement will be understood by reference to figs. 8 and 9.

To load: Cover the vent with the slide plate by which the locking-pin is raised up out of the recess in wedge and hammer; loosen and push wedge out by the hammer; force back the handle of stopper to withdraw the face from the bore, and then pull the stopper out to the side; the shot and cartridge can now be inserted, and the tin cup placed on the pin in the centre of the face of the stopper before the latter is replaced; the wedge is not pushed aside clear of the bore, for its end is hollowed out so that the shot can be loaded

*Fig 8, Plan.*




WEDGE BREECH-LOADING ARRANGEMENT, BRITISH GUN (64-PR.)

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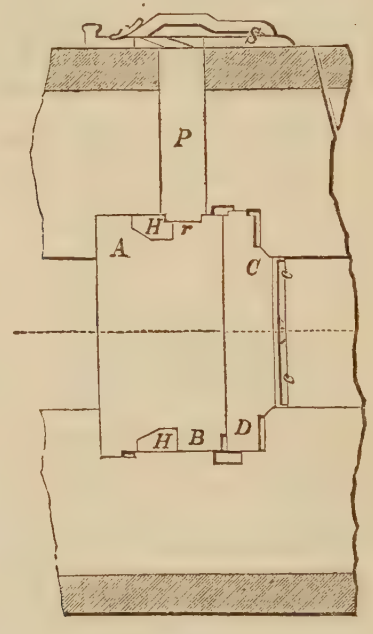
through it; the line *a*, *b* (fig. 8), shows where the hollow commences when loading, and *a* 2, *b* 2, the same when firing.

After the wedge has been replaced it must be tightened by a smart blow with the hammer; return the latter into the slot and draw the slide plate from the vent.

*Fig 9. Section.*




A B. Wedge.
C D. Stopper.
H H. Hammer.
P. Locking pin.
S. Slide Plate.
*c c*. Tin cup.

Both the screw and wedge breech-loading systems were designed by Sir W. Armstrong; the former is only suitable for small guns, the vent-pieces of large guns being unwieldy.

Wrought-iron carriage.

The iron carriages for the heavy guns consist of two brackets and a transom made of plate iron riveted to angle-iron, a bottom plate, four flanged feet with gun-metal trucks, elevating gear, and compressor. There is no elevating screw, but the breech of the gun is fitted on each side with a segmental arc, which is worked up or down by a pinion-wheel upon a spindle passing through the bracket; on each spindle, outside the bracket, is a drum, having a number of holes to receive the point of a lever employed to turn the pinion-wheel. The drum and pinion can be clamped against the bracket, to preserve the elevation.

The compressor consists of a number of iron plates suspended through the bottom of the carriage and fitting

between others in the platform or slide; on each side of the plates is a rocking lever, the lower arm of which bears against the outer plate, and on the upper arm is a nut to receive the screw-shaft, which, passing through the bracket, is worked by a lever handle. The screw on the shaft on the left side is only half the pitch of the other, and is termed the regulator-screw; the other is called the compressor-screw. The compression is thus given:—The lever handle of the regulator-screw is forced down through an arc corresponding to the amount of compression required, and then secured by a keep-pin passing through the handle and into one of the holes in a metal arc attached to the bracket. The compressor-screw is always pressed down through the whole arc, so that the plates are jammed against the rocking lever of the regulator-screw. It is obvious that by securing the lever handle of the regulator screw at different distances on the arc the amount of compression may be varied.

Should the gunner omit to press down the handle of the compressor-screw, a metal *tripper* attached to the platform or slide will catch the short arm of the handle and force the handle down through the whole arc. The arrangement is thus self-acting.

Models, &c.

Models of the 68-pounder on a naval slide, the 9-pounder bronze gun on a field carriage, and of two 24-pounders (of the eighteenth century) on siege carriages are exhibited. Also complete sets of the harness used in the service.

A 10-in. cast-iron mortar, on a travelling carriage, is exhibited. By removing the wheels the carriage serves as a bed. A forge waggon is also shown. Shafts are employed in the British service, in preference to the pole, for the draught of artillery carriages, their chief advantage being that the carriage is more under control for manœuvring or turning. The pole is generally in use on the Continent. The wheels in the British service have streak tires.

Muzzle pivoting.

Much attention having been devoted in England to the question of muzzle pivoting, it is disappointing not to find any carriage on this principle, or even designs or models, either in the War Office annexe or in that of the private British Exhibitors, although several excellent models are shown by Prussia and Austria. There are however some small models to illustrate Captain Heathorn's method of muzzle-pivoting in the building of the British Naval Exhibition. These models of carriages for turret, broadside, and casemate guns are exhibited under a glass case, containing Admiral Halsted's naval models, and as they are on a small scale, and not properly labelled, they may not probably have attracted much attention. In muzzle-pivoting

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the carriage and platform are so contrived that the gun can be trained horizontally and also be elevated or depressed without movement of the muzzle; the gun can thus be laid upon an object throught a port-hole or embrasure but little larger than the muzzle of the gun. This is of importance in consequence of the increased accuracy of fire of the rifled guns now used, and of the necessity of having but a small aperture in an iron shield to ensure strength.

Mr. R. Mallet, C.E., the author of "The Physical Con- "ditions involved in the Construction of Artillery," proposed some years ago several designs for muzzle pivoting, and more recently a carriage contrived by Lieut.-Col. G. Shaw, R.A., a 68-pounder, has been tried with success at Shoeburyness. In each bracket in Lieut.-Col. Shaw's carriage are two concentric arcs described from a centre at the muzzle of the gun, which is supported by two bands shrunk on to the piece, one before and the other behind the trunnion (which is cut off), and attached to the arcs; these arcs can be moved up or down by pinions worked by worm wheels outside the brackets, the worm wheels being connected by a shaft on each side of the carriage, and turned by hand wheels on the shafts.

Projectiles.

A large glass case contains specimens of all the ammunition manufactured in the Royal Laboratory at Woolwich, the shells, fu zes,&c. are shown both whole and in section. The spherical projectiles are round and case shot; common, mortar, Martin, and diaphragm shell; carcasses, parachute lights, smoke balls. The elongated projectiles are common, segment, shrapnel, and Palliser's shell. Of these it will only be necessary to refer to the Palliser shell and the Boxer shrapnel shell for rifled ordnance, the others presenting no novelty.

The Palliser shells, which are 7, 8, and 9 inches in diameter, are employed for the penetration of iron plates, for which purpose they have answered better than any other projectiles. As a material for firing against thick iron armour, ordinary cast iron is useless, breaking up without producing injury; wrought iron is too soft, a great proportion of the work on impact being expended in flattening out the shot; steel answers well, but is enormously expensive. The essential feature of the Palliser projectiles is that, being made of carefully selected brands of iron, and chilled in casting, they possess intense hardness, the property requisite in projectiles fired at iron plates with high velocities. Besides, however, this property, they have a pointed (ogival) head, which both theory and practice appear to prove is the most favourable form for the penetration of iron masses. An additional and

most important advantage is the cheapness of the manufacture of these projectiles, their cost being about one fifth of that of similar steel projectiles.

In the Boxer shrapnel for rifled ordnance (fig. 10) the essential features of a shrapnel shell are embodied. Such a shell fired from a rifled gun having, previous to breaking up, a rotatory motion, considerable lateral spread is given to the bullets when released; and in the segment shell this is increased in consequence of the charge being in the middle of the shell. In the Boxer shrapnel the charge is placed in a chamber at the base, so that on explosion there is no tendency to increase the lateral spread of the bullets, but rather to increase their velocity and penetration. A tube leads the flash from the fuze to the bursting charge. The shell is filled with bullets of lead imbedded in rosin. The spherical form and density of the bullets are better for range and penetration than the angular form and light material of the segments.

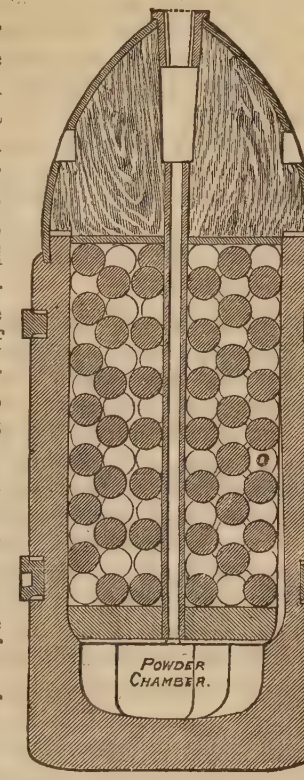


Fig. 10.—SECTION OF BOXER'S SHRAPNEL FOR RIFLED ORDNANCE.

The fuzes introduced since the last Exhibition are the two Boxer wood time-fuzes for rifled ordnance, one for muzzle-loading and the other for breech-loading guns; the Pettman general service, and the Freeth modification of the Armstrong percussion fuze. The two first are adaptations of the ordinary Boxer wood time-fuze to projectiles for rifled ordnance. In the service breech-loading guns, there being no windage, a percussion arrangement—a hammer suspended by a wire—is necessary to fire the composition by the shock of the discharge; but in the fuze for muzzle-loading rifled guns, which have windage, a plug takes the place of the hammer—the plug being required as, an elongated shell proceeding point first, the burning of the composition

Fuzes.

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of an open fuze would be affected by the pressure of the air during flight.

The Pettman general service fuze (fig. 11) has the following parts:—A, body; B, top plug; C, plain ball; D, steady plug; E, detonating ball; F, cone plug; G, lead cup; H, suspending wire. Round the top of the steady plug runs a groove filled with detonating composition, similar to that in the detonating ball.

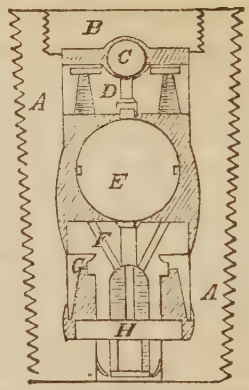


Fig. 11.—SECTION OF PETTMAN'S GENERAL SERVICE FUZE.

On the discharge of the gun the suspending wire is broken and the lead cup crushed, in consequence of the inertia of cone and steady plugs and of balls, which do not instantaneously move with the fuze and lead cup; sufficient space is therefore left for the disengagement of the balls, and on impact the fuze is ignited by the concussion of the detonating ball on the inside of the body, or by the plain ball on the composition in the steady plug, which continuing to move after the sudden check to the motion of the fuze presses the plain ball between itself and the top plug. This fuze will answer for the shells of either smooth-bored or rifled guns.

Freeth's modified percussion fuze consists of a body and hammer of gun-metal, a boxwood pellet driven with composition, and two brass cups, one for supporting the hammer and the other for guarding the detonator. A needle projects down from the top of the body, and in the top of the pellet is the detonating composition. The supporting cap is crushed on the discharge of the gun, and the other cup on impact, when the detonating composition of the pellet strikes upon the needle.

Rocket.

The ingenious rocket lately proposed by Mr. Hale is exhibited. In the base are three vents, and round one side of each vent is a circular metal plate projecting about two inches from the base; when the gas issues from the vents its pressure on the plates causes the rocket to rotate, and gives its longer axis stability during flight, thus avoiding the necessity of using a stick. These rockets are very accurate in flight.

Armour plates.

Two wrought-iron armour plates which have been penetrated are shown, as well as a number of photographs to

illustrate their gradual destruction by firing. One, which is 13·5 in. thick, formed the shield of the west embrasure of a granite-faced battery at Shoeburyness. It was fired at from a distance of 200 yards with 7 steel shot:—

| Gun. | Charge. | Weight of Shot. |
|---|---|---|
| 7-inch | 18 lb. | 115 lb. |
| 8 | 22 | 150 |
| 8 | 22 | 150 |
| 9·22 | 30¼ | 222 |
| 10 | 36 | 285 |
| 10 | 41¼ | 286 |
| 9·22 | 39½ | 221 |

The other plate, rolled by the Millwall Ironworks for H.M.S. Bellerophon, shows the effects of 18 projectiles at a range of 200 yards, the actual penetrations being produced by 7 in. shot of 115 lb. of steel or chilled iron (Palliser's), fired with charges of about 22 lb. weight.

Sections made of wood and iron, and representing the following targets, are exhibited:—Hercules, Lord Warden, Bellerophon, Minotaur, and Warrior.

These targets represent the different modifications made from time to time in the construction of ship-armour, to enable it to withstand the constantly increasing power of heavy rifled ordnance as shown in the numerous experiments carried on during the last few years at Shoeburyness and Portsmouth.

The Hercules, constructed in 1865, consists of 8 or 9-in. iron plates, backed by 12 in. of wood having ¾-in. horizontal iron plates 2 feet apart, and behind this two ¾-in. plates, 28 inches of wood, and a ¾-in. iron skin. This is the strongest ship-target yet constructed, but it is not intended as a covering for the whole of a ship's side, but merely to serve as a belt to protect the water line.

The Lord Warden, made in 1863, is a 4½-in. iron plate backed by 10 inches of wood, a 1½-in. plate, and behind this 20½ inches of wood.

The Bellerophon, constructed in 1863, is made up of a 6-in. iron plate, 10 inches of wood with horizontal ½-in. plates two feet apart, and two ¾-in. plates.

The Minotaur, made in 1862, is a 5½-in. plate backed by nine inches of wood, and a ⅝-in. skin.

The Warrior, constructed in 1861, consists of a 4½-in. plate, backed with 18 inches of wood, and a ⅝-in. skin.

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The respective weights, per square foot, of these different targets are:

| | Lbs. |
|---|---|
| Hercules (with 8-in. plate) - | 652 |
| Do. (with 9-in. plate) - | 689 |
| Lord Warden - - - | 483 |
| Bellerophon - - - | 393 |
| Minotaur - - - | 349 |
| Warrior - - - - | 341 |

## Private British Exhibition.

In an annexe adjacent to the one containing the war *matériel* shown by the British War Department are the munitions of private exhibitors.

Ordnance exhibited by Sir W. Armstrong & Co.

Sir W. Armstrong and Co., of the Elswick Works, have sent a 9-in. gun, rifled on the Woolwich system, and constructed like the service gun, except that it has a coiled instead of a steel tube. It is mounted for a broadside port on a wrought-iron carriage and slide, with a wooden framework in front to represent the section of an iron-clad frigate, and provided with an arrangement for loading the gun. A shot-bearer is suspended to an iron bar suspended above the gun at right angles to it. This bearer can be raised from the lower deck by pulleys, and then run along the bar until opposite the muzzle; the bar pivots at one end, but can slide on a short bar at the other end; so that the shot can be brought back close to the muzzle when the gun has recoiled.

The carriage differs in some respects from the service-carriage. The brackets are made of double plate (box-girder), instead of plate and angle iron; the clamp for the elevation is inside the bracket, and the breeching is stretched along the slide, below the carriage, and cannot get entangled.

A 12-pounder shunt rifled gun is shown: It has a steel barrel, with wrought-iron coils above, and is mounted on an iron bracket-trail carriage with iron wheels. The brackets, of plate and angle iron, meet in a point, and the wheels have sixteen spokes, any one of which can be easily removed by unscrewing two nut-washers. The elevation is given by a circular rack and pinion between the brackets, worked by a wheel handle outside the right bracket, and there is a lever clamp outside the left one. The motion is much more rapid than with the ordinary elevating screw.

A number of projectiles, whole and in sections, similar to the service shot and shell, are exhibited. These consist of 9-in. *chilled* shot and shell (Palliser's), 9-in. and 12-pounder common and segment, and 600-pounder common shell. LIEUT.-COL. OWEN ON ARTILLERY.

The Whitworth Company, Manchester, exhibit four rifled guns—a 10-pounder, 32-pounder, 70-pounder, and 150-pounder, and three 2-pounder howitzers, all made of tempered steel. The 150-pounder consists of four tubes, with trunnion-rings, the outer portions being forced on by hydraulic pressure. The barrels are bored through, and closed by a plug screwed in (a double plug for the 150-pounder, and a single plug for the others), and a copper cup to prevent the escape of gas and lessen the shock on the plug. Ordnance of the Whitworth Company.

| Gun. | Calibre. | Weight. | | | Charge. |
|---|---|---|---|---|---|
| | Inches. | Tons. | cwts. | qrs. | lb. |
| 32-pounder | 4·14 | 0 | 33 | 3 | — |
| 70-pounder | 5·5 | 4 | 2 | 3 | 10· |
| 150-pounder | 7·0 | 7 | 8 | 0 | 20· |

Extractors, sponges, and rammers for these guns are shown.

The 10-pounder gun weighs 7 cwt., and is a steel forging, with a trunnion-ring pressed on, and it is mounted on a wooden bracket-carriage, the brackets meeting in a point.

The 2-pounder howitzers each weigh 144 lb., and are made from solid forgings, with trunnions screwed on. One is mounted on a block trail-carriage, with an axletree-bed to take an axle for wheels or trucks, and is adapted to either mountain or boat service; another is on a boat-carriage, and the third is on a small ship carriage suitable for a yacht.

The rifling is the hexagonal system, with a simple six-sided projectile, without coating or studs. The form of the bore is not strictly hexagonal, and is thus described by Mr. Whitworth:—"The interior of each gun is first bored out cylindrically, and, when the rifling is completed, a small portion of the original cylindrical bore is retained along the centre of each of the sides of the hexagonal bore, and the other parts of each side recede or incline outwards towards the rounded angles, hence the diameter of the hexagonal bore is greatest at the rounded angles. This description will readily be understood by reference to the diagram (fig. 12), representing the section of the bore of a 7-in gun."

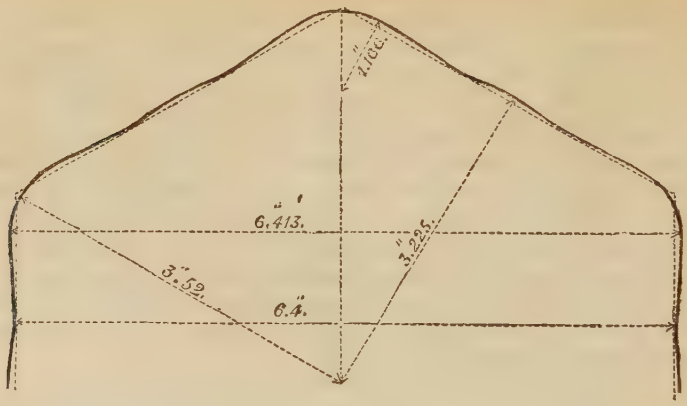


Fig. 12.—SECTION OF BORE OF WHITWORTH 7-INCH GUN.

The dimensions are correct, but the departure from the hexagon is exaggerated in the drawing, to make the form apparent. The twist of the rifling varies with the calibre of the gun, from 1 turn in 25 in. in the 2-pounder to 1 turn in 165 in. in the 9-in. gun.

The following projectiles are exhibited for the Whitworth ordnance:—

Common shell, 2, 6, 12, 32, and 70 pounders, and 7 in.

Solid shot, ditto.

Shrapnel (Boxer's).

All of which have rounded heads, and are made of cast iron.

Two 7-in. flat-headed shot, one of cast iron, to act as a pioneer (to ascertain elevation) for the other steel shot.

Case-shot, consisting of a strong iron case and ends, not fitting close up, but secured by three or more light pins. The interior is filled with lead, balls, and rosin; and the breaking-up depends upon three longitudinal grooves in the exterior of the case. This Whitworth case-shot was tried by the Armstrong and Whitworth committee, and pronounced to be a valuable invention.

Rifled spheres, or round projectiles with six segments taken off the outer surface to give the requisite hexagonal form, are also shown; they are slightly flattened at the top and bottom, so that when two or more are fired together they may be in contact. Three, which together are about equal in weight to the ordinary elongated shot, are intended to be fired at the same time against boats or such objects.

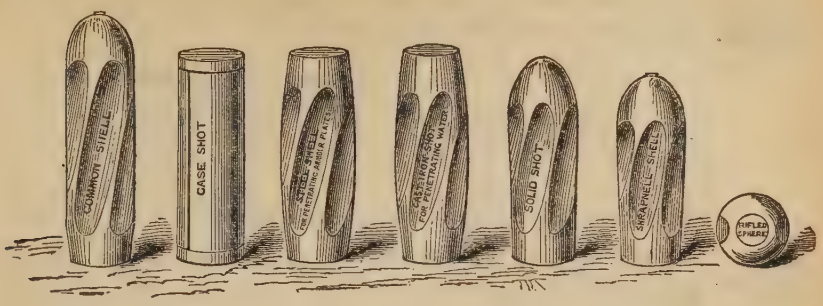


Fig. 13.—WHITWORTH PROJECTILES.

The Whitworth guns, being of steel, are very costly; but the projectiles can, no doubt, be cheaply and quickly made, merely requiring to be cast and then planed. Within the main building is a self-acting Whitworth machine for planing these projectiles, and it is stated "that a 150-lb. solid projectile can be cast, planed, shaped, and made ready for use by one man in twenty-eight minutes;" this cannot include cooling. The pattern and moulding box for a Whitworth elongated projectile is exhibited in the annex. There is a contrivance for giving the spiral to the interior of the mould.

Some Boxer fuzes are exhibited with the Whitworth projectiles.

It may be stated here that both the Armstrong and Whitworth 70-pounders stood in the competition trials over 3,000 rounds—that is, more than three times the number assigned as the limit to the endurance of the old cast-iron smooth-bored guns. It must, however, be remembered that as the size of the gun is increased the limit of endurance is sooner reached, the difficulties to be surmounted in the manufacture of large rifled ordnance, which will be subjected to the enormous strains caused by heavy projectiles and charges, being very great.

No Whitworth gun over 7-in. calibre has yet been made and tested by firing.

Major Palliser exhibits a 9-in. gun made of a coiled-iron interior with an outer jacket of iron cast over it. He has for a long time advocated the utilisation of the smooth-bored cast-iron guns for rifled ordnance, by boring them up, and inserting a coiled wrought-iron barrel; and such converted Palliser gun.

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guns have stood severe tests. The 9-in. gun shown has been subjected to the following proof:

| | Charge. | | Projectile. |
|---|---|---|---|
| 20 rounds with | 43 lb. | and | 250 lb. |
| 4 „ „ | 55 lb. | „ | ditto. |
| 87 „ „ | 45 lb. | „ | ditto. |

which has injured the bore to some extent.

Cail's and White's projectiles.

There are two exhibitors of projectiles having external grooves for the gas to act upon and give the shot rotation—Messrs. Cail and T. White. This method of giving rotation has not yet been tried with success, although numbers of such projectiles have been proposed and fired.

Brown's armour plates, &c.

Sir John Brown & Co., of the Atlas Works, Sheffield, the great manufacturers of armour plates, exhibit an enormous iron armour plate, 30 ft. long., 6 in. thick, and weighing 11 tons 5 cwt. Also several thick blocks and plates, steel tubes for guns, and steel projectiles, elongated and spherical.

Chalmers' models of armour plates.

Mr. Chalmers exhibits two models of his target, the peculiarity in the construction of which consists in the distribution of the wood and iron in the compound backing. This latter is made up of alternate horizontal layers of timber planking, 10 in. by 5 in., and iron plates 10 in. by 7-16 in, bolted together by vertical screws. Instead of putting the whole thickness of plate in front of the backing, a plate $3\frac{3}{4}$ in. thick is placed in front and a second of $1\frac{1}{4}$ in. behind the backing, and this inner plate is supported by a timber cushion of $3\frac{3}{4}$ in. and an iron skin of $\frac{5}{8}$ in. The objects aimed at in the construction of this target are:—"To obviate the evils resulting from a simple wood backing in buckling, penetration, &c., and to provide against the effects of vibration and distortion, as the fracture of plates and destruction of fastenings which must necessarily occur with rigid backings." It is intended to disperse the work of the shot over a large area. Experiment has shown that this target offers very great resistance to the penetration of projectiles—more, for instance, than the Lord Warden, a heavier target per foot.

Redford's target.

Mr. G. Redford shows a diagram to represent the construction of a target of corrugated steel backed with wood. He claims for such armour the mechanical strength of the double arch and that the shot would not be in perfect contact on impact; the latter is stated, however, on the assumption that the shot would be flat-headed.

## French Government.

The French Goverment has sent a considerable amount of artillery *matériel*, which is displayed in and just outside of an annex on the left of the Pont d'Jena entrance ; but the guns are only of comparatively small calibre, none of their heavy breech-loading rifled guns being shown.* The heaviest gun exhibited is a muzzle-loading rifled gun of cast iron, strengthened with steel hoops, mounted on a cast-iron carriage and slide, and intended for naval service. It weighs 98 cwt. ; its calibre is 6·48 in. ; and it fires a projectile of about 70 lb., with a charge of 8 lb. It has six grooves.

Bronze rifled ordnance.

The other guns outside the annexe are bronze canon de 24, 12, and 4 (both field and mountain), rifled on the La Hitte system, with six grooves, and mounted on their respective carriages ; a coast battery canon de 16, on a wooden frame carriage and traversing platform ; several bronze mortars—one, de ·32 (12·787 in.), on a platform waggon ; another de ·27 (10·787 in.), on an iron bed ; and a small ·15 mortar, on a flat wooden bed, with poles attached through rings on each side for transport ; an ammunition, a forge, and a sling waggon.

One of the canon de 24 deserves notice. It has no preponderence, and is mounted on a short wrought-iron bracket-carriage, which has no elevating screw, but a clamp at each trunnion-hole, and allows of an elevation of 60 deg. being given to the gun if necessary ; the brackets are connected by a front transom, three bolts, and an iron axletree. The strengthened cast-iron gun has no preponderance, and its carriage is arranged in the same way, to allow of both horizontal and vertical fire.

The field-gun carriages have wooden block trails and iron axletrees, without wooden beds ; the canon de 12 has no axletree boxes ; but the canon de 4 has one on each side. The wheels have ring tires.

Inside the annex is a canon de 12, limbered up and fully equipped with four (model) horses, provided with the light *bricole* harness, which has a breast-strap instead of a collar. This harness has been lately adopted for the French service, and is said by French artillery officers to answer well.

There are two mules equipped for mountain service, one carrying the gun, shafts, and side-arms, and the other the carriage and wheels. Also a small bronze rifled gun, on

* They were not sent until July, but are described further on.

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a light iron frame-carriage, two small mortars (one iron, the other bronze), and a number of rockets with flanged sticks.

Besides the above, the annexe contains a case of models of guns and carriages, and the ballistic pendulum used for musket bullets in 1847. Under the case are arranged the different service, spherical and elongated, projectiles; above are photographs of the heavy gun elevated on its carriage at 45 deg., of breaches in revetments, &c.

The following table gives the weights, &c. of the French bronze rifled ordnance:—

| Gun. | Weight of Gun. | Cal. | Charge. | Twist of Grooves. | Weight of Shell. |
|---|---|---|---|---|---|
| | Cwt. | Ins. | lb. | Cals. | lb. |
| Canon de 24 (siege) - - - | 39½ | 6 | 5·51 | 1 in 30 | 50 |
| Do. 12 (field or position) - | 12 | 4·7 | 2·19 | 1 in 24·7 | 25·4 |
| Do. 4 (field) - - - | 6½ | 3·4 | 1·19 | 1 in 26 | 9 |
| Do. 4 (mountain) - - | 2 | 3·4 | ·62 | 1 in 26 | 9 |

All these guns are rifled on the *système la Hitte*, with six angular grooves, the inclination of the driving side being less than that of the other side, so that, when the shell passes up the bore on coming out, the studs rise up the side of the grooves, and the projectile is centred.

Fig. 14 represents sections of the stud and groove. By centering the projectile the wear of the bore is said to be greatly decreased.

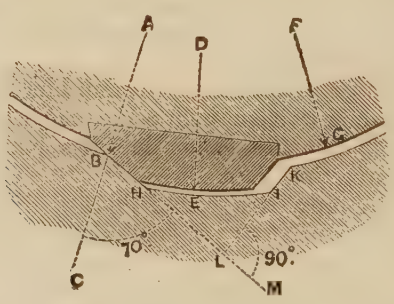



Fig. 14.—SECTION OF STUD AND GROOVE, FRENCH FIELD RIFLED ORDNANCE.

The width of the groove is contracted, like that of the shunt gun, near the bottom of the bore. The projectiles supplied to the guns are common and shrapnel shell and case-shot; the two former are cylindro-ogival in general

form, but are flattened at the top, and they have two rows of zinc studs.

Heavy rifled guns.

The French have adopted for naval service four different natures of heavy breech-loading rifled guns, which are made of cast-iron, strengthened behind the trunnions with steel rings shrunk on, Fig. 15. The castings are made at the Imperial foundry at Ruelle, near Angoulême, but the steel rings are supplied by MM. Petin and Gaudet. The breech-loading arrangement is similar in principle to that proposed by Eastman, several of whose guns were purchased by the British Government during the Crimean War, but have never been used.

The bore is closed by a steel plug, with a thread on its exterior surface, fitting into a screw in the breech of the gun: a brass tray hung on hinges supports the plug when withdrawn from the gun previous to loading, Fig. 16. The thread does not extend round the plug, but it consists of three separate equal portions, which together cover one half of the surface of the plug, the thread is removed from the three intervening spaces, and this is also the case in the breech. The plug can, therefore, be easily entered, its screwed portions passing up the plain surfaces in the breech; but when pressed home and turned by a lever handle through $\frac{1}{8}$ of a circle, the threads of the plug lock into those in the breech, and the plug is secured in its place. The lever when pressed down passes a spring catch, which secures it and prevents the plug unscrewing itself, Fig. 17. The lanyard is nipped by the catch until the lever is pressed down, when it is released, so that the gun cannot be fired until the plug is home. Attached to the face of the plug is a circular steel plate with a steel cup screwed on to it to prevent the escape of gas, Fig. 18. A thick wad of dried seaweed is put between the cartridge and the base of the projectile. The chief points respecting these ordnance are given in the following table:—

| Gun. | Weight. | Calibre. | Charge. | | Projectile. | |
|---|---|---|---|---|---|---|
| | | | Battering. | Service. | Battering. | Service. |
| | Tons. cwt. | ins. | lbs. | lbs. | lbs. | lbs. |
| Canon de 27 c/m | 21 13 | 10·82 | 66·2 | 53 | 476 | 310 |
| „ 24 c/m | 13 16 | 9·45 | 52·9 | 35·3 | 317 | 220 |
| „ 19 c/m | 7 17·6 | 7·64 | 27·5 | 17·6 | 165 | 115 |
| „ 16 c/m | 4 18·5 | 6·48 | 16·5 | 11·0 | 99 | 69·5 |

CANON DE 24 c/m.

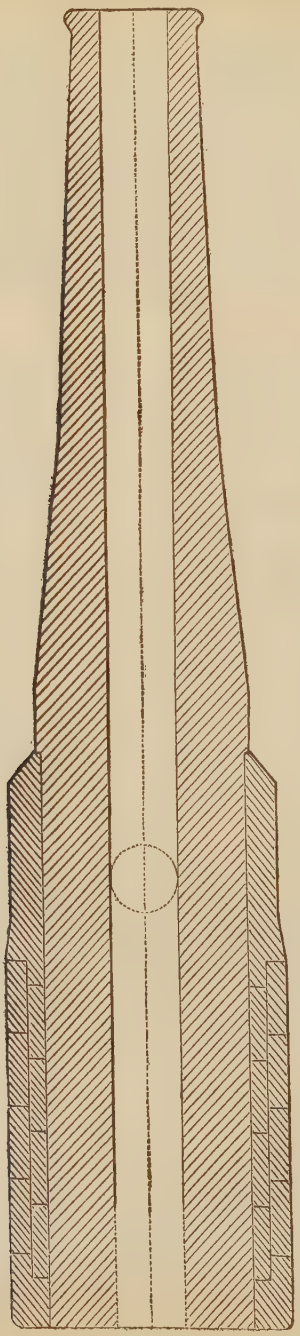


Fig. 15.— SECTION SHOWING STEEL RINGS.

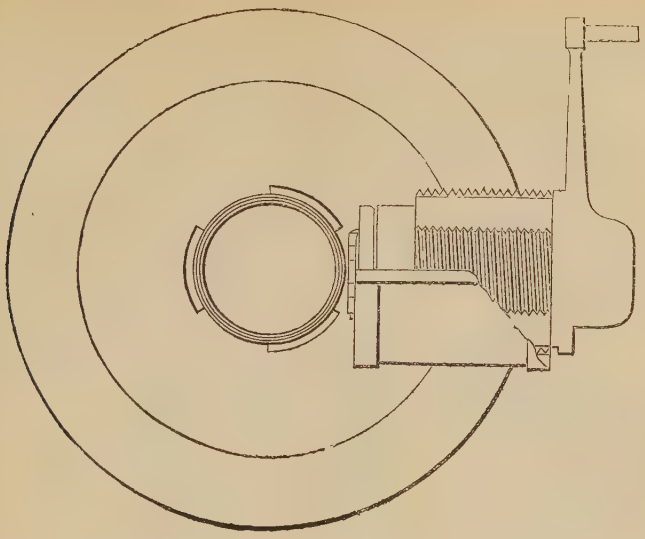


Fig. 16.—BREECH OPEN (PART OF TRAY REMOVED TO SHOW FORM OF BREECH-PLUG.)

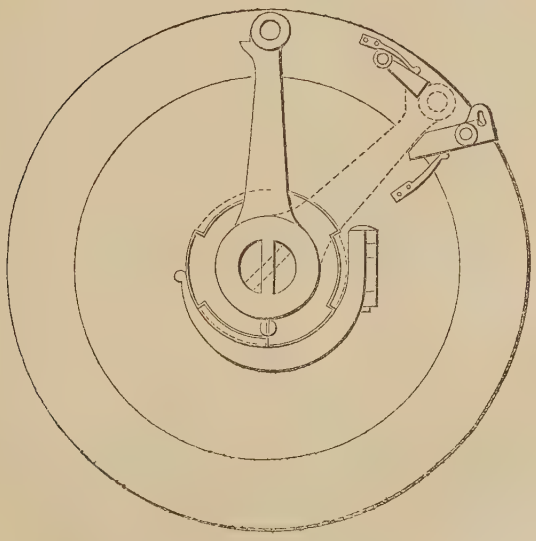


Fig. 17.—BREECH CLOSED.

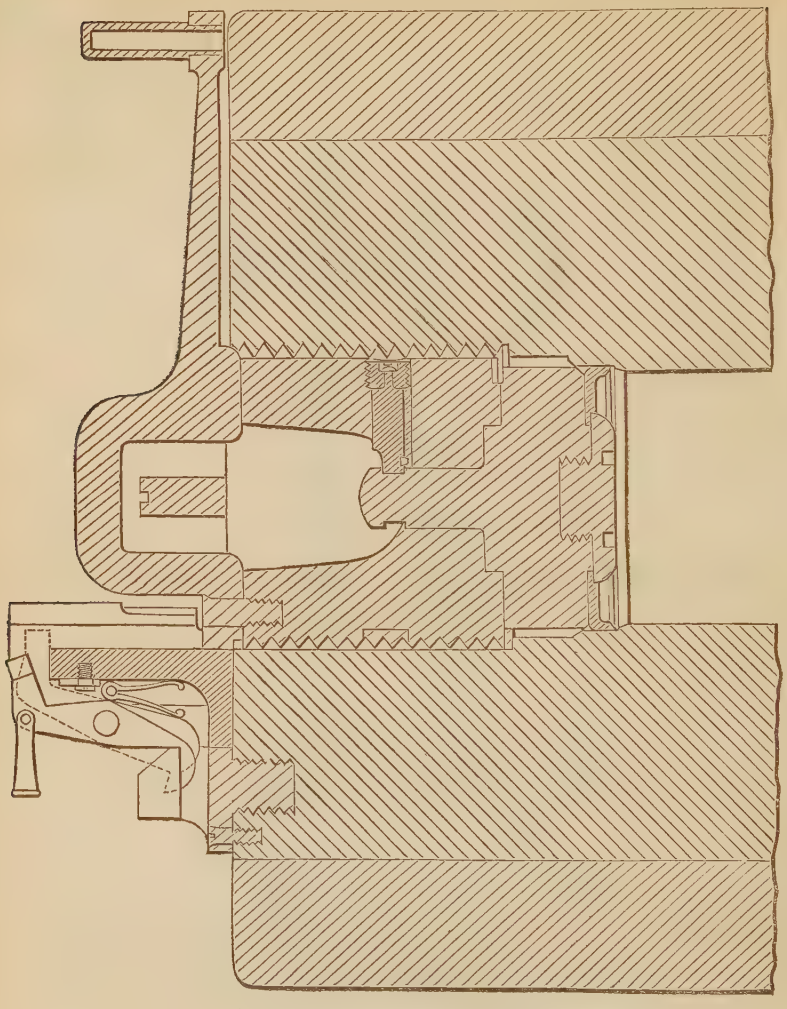


Fig. 18.—BREECH CLOSING ARRANGEMENT.

The charge is therefore rather more than $\frac{1}{6}$th of the projectile. The canon de ·16 has three grooves; the others have five. The twist of the grooves is increasing, from 0 to 1 turn in 30 calibres at the muzzle. A large amount of windage, ·2 inch, is given. These guns are mounted on wrought-iron carriages and slides, on the box-girder construction; the breech of the gun in these carriages is supported by a chain suspended between the brackets.

The compression is given on both sides by a brake of gun-metal embracing the sidepiece of the slide, the thickness of

which increases from front to rear, so that the compression becomes greater as the piece recoils. The projectiles, which have copper studs, are common shell, and both flat-headed and pointed steel shot, the flat-headed being for close quarters. LIEUT.-COL. OWEN ON ARTILLERY

None of these guns were, however, exhibited until July, when two were sent, and a monster breech-loading smooth-bored piece of similar construction, but of 42 centimetres (16½ in.) calibre. This gun weighs 38 tons, and is intended to fire a solid spherical shot of 660 lbs., with a charge of 110 lbs., and a spherical shell of 462 lbs., holding a bursting charge of 19·8 lbs., with a charge of 72·6 lbs. The endurance of the strengthened rifled ordnance, before described, is very doubtful, the results of our own experiments and the failure of the Parrott rifled guns in America proving that little reliance can be placed on cast iron, even when strengthened for a rifled piece. As, however, shells with studs are used, and there is therefore a certain amount of windage, the strain will probably be less than with projectiles having expanding envelopes which fill up the bore. It is also only fair to state on the authority of a French naval officer that one of the 24 $^{c}/_{m}$ guns has stood over 1,000 rounds with battering charges and projectiles. The French powder burns more slowly than our own, and does not give so high an initial velocity.

In the French Marine Department are two armour-plates, both having three flat-headed shot sticking in them; one has broken off at the base, and all have recesses for studs (the largest in front) for three grooves. Thickness of the plates, 8·6 in.; calibre of the rifled gun, 9·4 in.; weight of the cast steel cylindrical shot, 319 lbs.; charge, 55 lbs.; range, 21·8 yards. The gun used was probably the breech-loading rifled canon de 24$^{c}/_{m}$. The plates are buckled and cracked behind the points of impact, and some of the bolts are broken, but there is no penetration. The plates appear to consist of twelve thin strips about 5 in. deep, built up and welded together, and to have been attached by long screw-bolts to a wooden backing.

## MM. Petin and Gaudet.

To the right of the Pont d'Jena entrance is an annexe containing the objects exhibited by MM. Petin and Gaudet, the celebrated French steel manufacturers. They consist chiefly of blocks for guns, hoops, and trunnion-rings, made of coiled soft steel; the coils are welded by hammering and flattening, and the rings are tempered and annealed. Besides 1,700 French guns, MM. Petin and Gaudet have supplied foreign Gun-blocks, plates, and projectiles.

Lieut.-Col. Owen on Artillery.

Powers with steel rings for*—800 guns to Italy; 500 to Spain; 120 to England; 180 to Denmark; 130 to Russia; 24 to Turkey; 40 to Norway; total, 1794.

A large steel block, bored through, turned, and provided with trunnions, is shown, but the bore is not closed; it is mounted on a service wrought-iron carriage, having a chain suspended between the brackets to support the breech, and the chain can be tightened or released by turning two handles, one outside each bracket. The weight of the block is 15·7 tons, and its calibre is 9·45 in.

There are trunnion-rings for guns of 16, 19, 24, 27, and 42 centimetres, the breech portion of a gun with trunnion-ring, and a number of rough coils. Steel projectiles spherical, cylindrical, and cylindro-ogival, of 16, 19, 20, 24, 27, 32 and 42 centimetres diameter. A steel canon de 12, weighing 11·7 cwt., mounted on a block-trail wood carriage; the bore of this gun is not closed. Also some armour-plates, with a number of indentations in them.

## Holland.

Ordnance carriages and projectiles.

The Dutch Government exhibits the following pieces of ordnance in an annexe outside the portion of the main building allotted to Holland.

A rifled 20-pounder cast-iron gun, lined with bronze.

A rifled canon de 4 lined bronze gun.

A small rifled piece (canon de 1) for boat service.

A small bronze mortar.

All but the first have locks attached to them for firing the piece.

The object of lining the guns was to save expense by the conversion of the smooth-bored into rifled ordnance. Some difficulty was at first experienced in lining the iron guns, the bronze shrinking away from the iron in cooling. The displacement of the lining is now prevented by cutting a number of grooves in the iron bore at right angles to the axis. These grooves are filled by the melted bronze, which is also afterwards expanded in the proof.

The 20-pounder and canon de 4 have six grooves; the small boat-gun only four. The grooves of the 20 pounder and small gun are rectangular in section; those of the canon de 4 have one side curved. The projectiles, common and shrapnel shell, have zinc buttons. The 20-pounder is mounted on a bracket trail wooden travelling carriage, and the canon de 4 on a wooden block trail carriage. The limber of the latter has two very large boxes, each holding twenty-four

* "L'Artillerie Moderne," par M. Turgan, p. 34.

rounds, and a couple of small boxes between the others for fuzes; four case shot are carried on the left axletree. The canon de 4 is a converted smooth-bored 6-pounder, and it fires a common shell of 9 lbs., and a shrapnel of 11 lbs; the gun weighs about 7 cwt. The vent of this gun is in the curved portion of the breech, and the lock is attached to the loop of the cascable; a small tube placed in the vent is fired by the hammer of the lock striking a copper cap placed over the tube. A complete set of harness is shown.

## BELGIUM.

Frederix's method of closing bore.

Belgium merely exhibits a cast-iron gun converted into a rifled breech-loader on the Wahrendorff system, but with lead-coated projectiles. A peculiarity in this gun is the contrivance for effectually closing the bore (fig. 19), which is the design of M. A. Frederix, at Liège. The plug is made of steel and is conical in form, and on to the cone a steel ring fits, a copper plate being attached in front; as the ring is forced back it expands, but in consequence of its elasticity regains its former position after firing. This gun is said to have been fired 50 rounds with 90 lb. shot and 13 lb. charges.

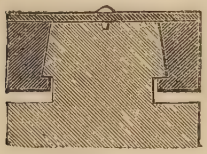


Fig. 19.—PLUG OF BELGIAN BREECH-LOADER.

## PRUSSIA.

Krupp's guns.

The Prussian Government exhibit nothing, but M. Fried. Krupp, the great cast-steel manufacturer of Essen, in Prussia, has sent a fine collection of cast-steel forgings, among which are many ordnance and projectiles. The enormous scale on which M. Krupp's works are conducted will be understood when it is stated that they cover about 450 acres of ground, about one-fourth of which is under cover; that the number of men employed is 8,000, besides 2,000 more in the coal mines at Essen, at the blast furnaces on the Rhine and at the iron pits on the Rhine, and in Nassau; also, that during last year the produce of the works was 61,000 tons, by means of 112 smelting, reverberatory, and cementing furnaces; 195 steam engines, from two to 1,000 horse power; 49 steam-hammers, from one to 50 tons (the blocks); 110 smiths' forges, 318 lathes, 111 planing machines, 61 cutting and shaping machines. The establishment has already delivered 3,500 guns, valued at over 1,050,000*l.*, and it has received orders for the immediate delivery of 2,200 more. Most of the guns made are rifled breech-loaders, from four to 300 pounders.

LIEUT.-COL. OWEN ON ARTILLERY.

Ordnance, carriages, &c. exhibited by Krupp.

The ordnance exhibited within the main building are, with one exception, rifled breech-loaders, the chief particulars respecting which will be found annexed.

| Gun. | Weight of Gun. | Calibre. | Length. | No. of Grooves | Charge. | Projectile. Shot Weight. | Shell. Weight filled. | Shell. Burster. | System of Breech-loading. |
|---|---|---|---|---|---|---|---|---|---|
| | Tons. | in. | in. | | lb. | lb. | lb. | lb. | |
| 1000-pr. | 50 | 14 | 210 | 40 | 110 to 130 | 1,212 | 1,080 | 17 | Krupp's cylindro-prismatical wedge. |
| 9-in. | 12¾ | 9 | 180 | 32 | 40 to 50 | 330 | 275 | .. | Ditto. |
| 6-in. | 4½ | 6 | 144·5 | 24 | 10 to 12 | 90 | .. | .. | Krupp's single rectangular wedge. |
| | lb. | | | | | | | | |
| 6-pr. | 948 | 3·5 | 78 | 18 | 1¼ | .. | 14·8 | .. | Wahrendorff. |
| 6-pr. | do. | do. | do. | do. | do. | .. | do. | .. | Prussian double wedge. |
| 4-pr. | 605 | 3 | 74 | 21 | 1 | .. | 8½ | .. | Krupp's semi-cylindrical wedge with Broadwell rings. |

The twist given to the grooves is according to the order received.

The 1,000-pounder has a forged inner tube strengthened with three layers of rings over the powder-chamber and two layers over the muzzle portion; the rings are forged from ingots without welding. The manufacture of this gun continued during night and day for 16 months, and the cost of the piece is 15,750*l*. The breech-loading arrangement is complicated, and some time would be necessary to go through the different operations in loading. The bore is closed by a steel plug and copper ring, which are supported by two wedges, a large one in rear and a small one working on the front of the other; the large wedge is cylindrical in form behind, so that the strain may be distributed, and not received by rectangular surfaces, which are liable to fracture at the angle. The projectile and charge are inserted at the right side, the wedges having been previously loosened by a screw on the other side, the plug removed by another screw fitted to the front of the rear wedge, and the wedges drawn out and made to rest upon a bed attached to the left side of the breech. The shot-bearer is raised by a derrick, and the projectile is forced home by a screw worked from behind the breech. When loaded, the wedges and plug are replaced, and the front wedge is worked in by a screw until it gives by pressure the requisite support to the plug.

The gun is mounted on a carriage, having solid steel brackets, and weighs 15 tons. This gun has never been fired.

The 9-in. gun is forged from one ingot, except the trunnion-ring, which is a separate forging. The breech-loading arrangement is a simple cylindro or round-backed wedge, the flat front surface forming the bottom of the bore; it can be quickly moved in or out by means of a screw in the top of the wedge, working half in the latter and half in a nut let into the metal of the gun above. To force the wedge completely home, another screw in the back of the wedge is, however, necessary. The nut in which this second tightening screw works has a certain play right or left, but it can be rendered immoveable by the head of a catch pin behind the wedge and at right angles to it, being screwed forward into a slot cut in the back of the nut. The nut being thus fixed, after the wedge has been brought nearly into its place by the first screw, the point of the tightening screw pushes the wedge home (figs. 20, 21 and 22). The round-backed wedge has the following advantages over the rectangular wedges; it has no angular supporting surfaces, the strain is more uniformly distributed, and the wedge is stronger. The escape of gas is prevented by the use of a copper cup, inserted when loading. A shot-

KRUPP'S CYLINDRICAL WEDGE (9-INCH B.L. GUN).

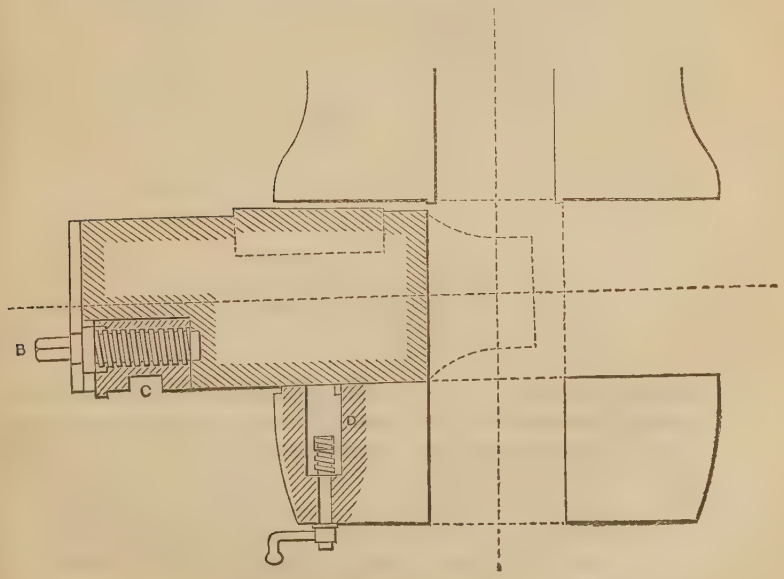



Fig. 20.—HORIZONTAL SECTON.

Fig. 21.—SIDE VIEW.

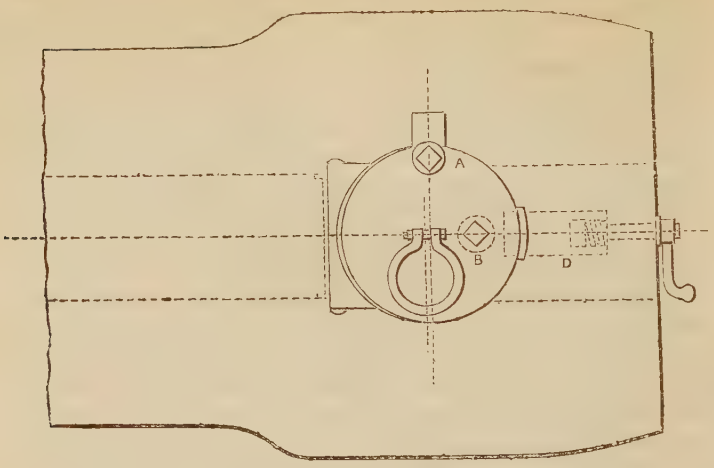
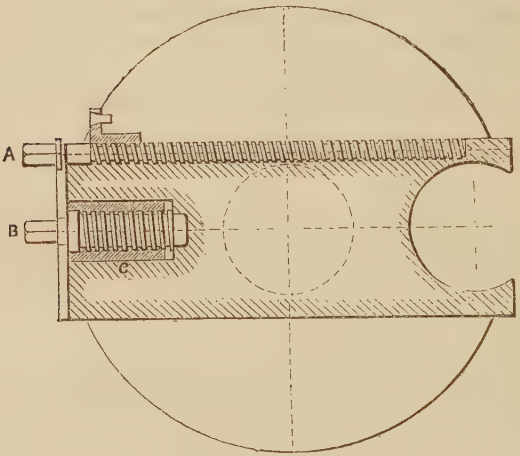



Fig. 22.—VERTICAL SECTION.




A. Screw for moving wedge in or out.
B. Screw for tightening wedge.
C. Nut of tightening screw.
D. Catch-pin.

bearer is attached behind the breech, through which a wooden loading-box, with the projectile in it, is inserted, and the shot thus prevented from catching in the wedge slot. The wedge can be easily and rapidly worked. This gun has been fired 120 rounds with 45-lb. charges, the powder used being, however, not so quick in its action as the English powder. It is said the Russians have adopted this system of breech-loading for heavy rifled ordnance.

The 6-in. gun is forged from one ingot, and has the single rectangular wedge, of which no more will probably be made, the round-backed wedge being a stronger construction. It has been fired 100 hundred rounds with 12-lb. charges, but the weight of the projectile is not given.

The 6-pounders are each forged from one ingot. One has the Wahrendorff and the other the Prussian double-wedge system of breech-loading; and the former is mounted on a wrought-iron field-gun carriage of the Russian pattern, having a bracket trail, with a traversing arrangement of the brackets on the trail, and an attached iron handspike.

The 4-pounder is forged from one ingot. The one shown belongs to the Prussian Government, and is mounted upon one of the service carriages. The breech-loading arrangement, which is simpler and stronger than the double-wedge, consists of a semi-cylindrical wedge, round behind but rectangular in front, working in a slot passing through the breech. On the face of the wedge is a steel (Broadwell) ring, which when home fits against a similar ring in the bottom of the bore. The wedge is provided on the left side with a screw turned by a lever handle; this screw works into a thread running across the breech over the wedge, which is brought into its required position by turning the handle. A locking-pin drops down from the top of the breech into a shallow groove in the upper surface of the wedge and keeps the latter securely in position. The general form of the wedge and rings will be understood by reference to the rough sketches in figs. 23 and 24. The carriage has a wrought-iron bracket trail, a seat on the axletree on each side of the trail, an attached iron handspike, wheels with

KRUPP'S SEMI-CYLINDRICAL WEDGE FIELD GUNS.

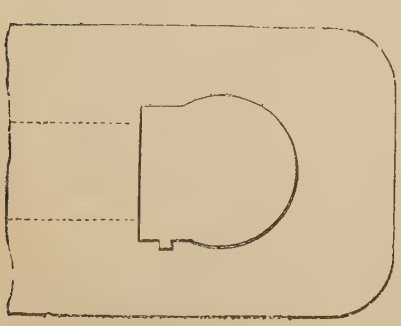


Fig. 23.

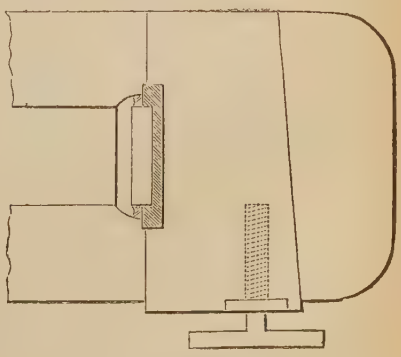


Fig 24.

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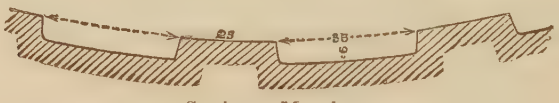
gun-metal naves.* and ring tires. This and other similar guns supplied to the Prussian Government have been tested with increasing charges up to $3\frac{3}{4}$ lb. and 122 lb. shot.

M. Krupp also exhibits a small rifled muzzle-loading steel gun, for mountain service, on the French model. It weighs 215 lb., its calibre is 3·4 in., and the weight of its shell is $6\frac{1}{2}$ lb.

Fig. 25.—GROOVE OF PRUSSIAN GUN.



Section at Muzzle.

Section at Shot Chamber.

Krupp's projectiles.

Some hammered steel projectiles are shown, prepared for lead-coating. The lead is cast round the projectile and attached by undercut projecting rings running almost round the shot, portions of the complete rings being cut away vertically; round the outer surface of the lead coating are a number of grooves, to allow space for the lead drawn down in passing through the bore. The projectiles are cylindro-ogival in form, and have a screw-plug at base to admit the bursting charge. Figs 26 and 27.

Fig. 26.—PRUSSIAN COMMON SHELL.

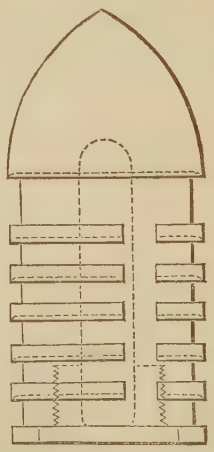


Fig. 27.—KRUPP'S STEEL SHELL. (WITHOUT LEAD COATING.)

* The bolts pass through the bottoms of the spokes and not between them, as in the Madras pattern nave.

M. Berger sends three breech-loading guns, a rifled 4-pounder, with double wedge; a smooth-bored 8-pounder, with single wedge and Broadwell rings; and a smooth-bored 8-inch, with double wedge, and weighing 110 cwt. Also some steel projectiles, similar in form to those shown by Krupp.

Berger's ordnance and projectiles.

M. Grusen, of Magdebourg, exhibits a 4-pounder cannon with Wahrendorff breech-loading arrangement; to prove the strength of the metal it was fired 40 rounds after a portion of the breech had been turned off to reduce the thickness of metal. Some projectiles similar to the Prussian, both whole and fractured, and a mould for casting the lead round them, are shown.

Grusen's ordnance and projectiles.

Also, a model of a muzzle-pivoting carriage and platform for a coast battery. The principle of the carriage is similar to that proposed by Colonel Shaw, R.A., but the construction is complicated and cumbrous. The carriage has high wrought-iron brackets, having two concentric arcs cut in each, the centre of the arc being at the muzzle. The trunnions of the gun run in the rear arcs, and are moved up or down in them by slides working below them in the arcs. and attached to a frame under the gun between the brackets; the frame has slides running in the front arcs (one on each side), and a metal band in front supporting the gun at a short distance from the muzzle.

Grusen's muzzle-pivoting carriage.

The frame is raised up or down by hydraulic pressure. Below the front of the carriage is a reservoir of water in connection with a ram, which is attached to the under part of the frame. The pressure is given by a pump on the left bracket, in line with the breech of the gun, and connected by a pipe outside the bracket with the reservoir. An arc in rear shows the elevation. The bottom of the platform is curved, and the platform is traversed on racers by a system of cog-wheels.

## German States.

The Saxon Company's cast-steel works at Dresden exhibit a rifled steel 4-pounder, and two breech-loading steel guns, a 4-pounder and an 8-pounder; but these present no peculiarity.

Ordnance exhibited by Saxon Company.

## Austria.

The Austrian Government exhibit an 8-pounder on travelling-carriage complete; 4-pounder, ditto; ammunition-waggon, mountain service equipment, Hale's rockets and a rocket tube, harness complete for a battery, and projectiles for the service of rifled guns. Both guns are rifled bronze

Ordnance and carriages.

LIEUT.-COL. OWEN ON ARTILLERY.

pieces, the 8-pounder having eight grooves, and the 4-pounder six grooves. The form of the grooves in section is what is termed saw-shaped (fig. 28).

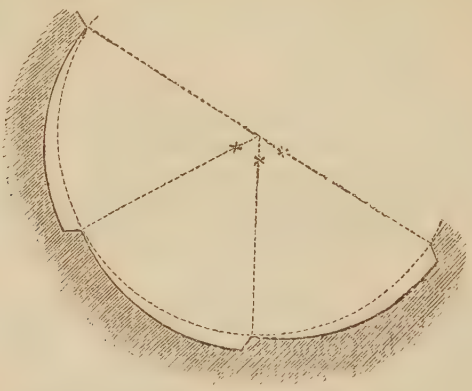


Fig. 28.—GROOVE OF AUSTRIAN FIELD GUNS.

The 8-pounder is mounted on a wooden carriage, having a very long bracket tail, upon which rests a box to contain ammunition, and also to serve as a seat for two men. The fore wheels are of smaller diameter than the hind wheels; no boxes are carried on the axletree, but one on the limber; the elevation is given by a handle outside the left cheek of the trail; and a pole is used for draught. The 4-pounder has also a bracket tail carriage of similar construction, but lighter, and only room for one man on the trail box. The ammunition-waggon is for the 4-pounder; it has a bracket perch, and carries two ammunition-boxes, one of immense size on the body and a smaller one on the limber.

A wheel having an iron nave with bolts passing through the bottoms of the spokes, and the machinery for making it, are shown. All the wheels have ring tires.

Rocket and tube.

The rocket-tube consists of a strong iron barrel, with straight internal flanges to centre the rocket, mounted on a tripod stand with an elevating arc. The rockets are of the pattern proposed by Mr. Hale some few years ago; they have a central vent at the base for the escape of the gas which projects them, and a number of tangential holes round the head for the gas intended to give rotation.

Projectiles.

The projectiles are common and shrapnel shell, carcass, and case shot. In the shrapnel the burster is at the base of the shell, as in Boxer's shrapnel for rifled ordnance. The general form of the shell is cylindro-conoidal, but flattened at the top. The shells are coated with tin and zinc, and have ribs of this soft metal to fit the grooves of the gun.

Two models of guns, mounted on wrought-iron carriages for coast batteries, are exhibited. The racers are arranged for muzzle-pivoting, and, by the construction of the carriages, the muzzle would move but slightly in giving elevation.

LIEUT.-COL. OWEN ON ARTILLERY.

Coast battery iron carriages.

## SPAIN.

The Spanish Government show nothing but a collection of models, which are, however, well executed, and are said to represent guns and carriages, &c. actually in the Spanish service. The models consist of—

A field gun, with carriage and four horses, each having a heavy saddle and collar.

Models of bronze ordnance and carriages.

Ditto, with carriage and six horses, having very light bricole harness.

A position or heavy field gun, with carriage and six mules.

A siege gun, on a travelling carriage.

All these guns are bronze rifled pieces, having six grooves, and the carriages have wood block trails and pole draught.

A rifled bronze gun, with three grooves, on a standing carriage, with a limber running on trucks under the rear axletree and wheels on the front axle.

Three ammunition waggons, very similar in construction to those in the British service, and a forge wagon.

A wooden gun-carriage, on a traversing platform, and a platform very similar to Col. Clerk's in construction.

Two large bronze mortars, on beds having brass brackets, and a small bronze mortar on a wooden bed, with piles of shells and side-arms.

A rifled bronze field-gun, with six grooves, mounted on a block-trail wrought-iron carriage with wooden wheels.

A sling-cart, sling-waggon, and devil-carriage, all of iron, with iron wheels.

Models—iron carriages.

Two heavy cast-iron rifled guns, strengthened with steel over the breech, and with three grooves in the bore; and projectiles for them, having two rows of white metal studs.

Models of iron ordnance.

A mountain-train equipment complete, consisting of nine mules, three abreast:—

Models of mountain equipment.

| | | |
|---|---|---|
| First rank | A mule carrying gun. | |
| | Do. | do. ammunition. |
| | A riding mule for officer. | |
| Second rank | A mule carrying gun. | |
| | Do. | do. wheels. |
| | Do. | do. carriage. |
| Third rank | Do. | do. ammunition. |
| | Do. | do. carriage. |
| | Do. | do. wheels. |

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The guns are bronze rifled pieces, with six grooves; and the mules have pack-saddles, upon which the gun or carriage rests.

## Sweden.

Ordnance.

Three guns are exhibited in an annexe. A large cast-iron rifled gun, strengthened by steel hoops over the breech, and a large cast iron smooth-bored gun, both muzzle-loading, and made at Finspong in 1866. A bronze rifled field-gun, on a wooden bracket trail carriage; the bore of the large rifled gun has three grooves, and that of the latter four grooves.

Projectiles.

Inside the main building are a number of projectiles used in the Swedish service. Large solid shot and common shell, of cast iron and cylindro-ogival in form, with three rows of white metal studs for nine grooves. Small cylindro-ogival projectiles, having studs for three grooves; the front studs are of white metal, but the bottom row is of brass, which, not being in the same inclined line as the top row, are probably intended to steady the shot on the lands. An elongated shot, with two rows of wooden studs for four grooves; and a number of spherical projectiles, consisting of common and diphragm shell, both whole and in sections.

## Russia.

Ordnance blocks and armour plate.

Russia has obtained considerable numbers of guns from Krupp; but the Government has established three steel factories, two of which send gun-blocks to the Exhibition. Four such steel blocks, smooth-bored, are in the main building: their calibres are 6 in., $5\frac{3}{4}$ in,, 4 in., and $3\frac{1}{4}$ ins., respectively. An iron plate, $4\frac{1}{2}$ in. thick, is also shown. It has been penetrated in four places and indented and cracked in six others, an 8-in. ball sticking in one of the indentations.

## Italy.

Armour plate and projectiles.

Two iron armour-plates, forged in the factory of Consaldo and Co., at Sampierdarena. One has a number of indentations, said to have been made at 12 metres' distance, but no other particulars are given. They appear to have been produced by 7-in shot. Some steel flat-headed shot of 6 in. or 7 in. diameter are also shown by the same company.

## Egypt.

Mountain bronze gun.

The Viceroy of Egypt has sent a small bronze rifled gun, mounted on a block-trail wooden carriage, with shafts for single draught. It was cast at Cairo, and is intended for mountain service. It has six angular grooves.

## America.

Ferris gun.

The American Government, which possesses such large numbers of ordnance, some of immense size, exhibit nothing. The only piece of ordnance in the American department is what is termed the Ferris gun, which is absurdly heavy in proportion to its calibre. It is a built-up, breech-loading rifled gun, with 20 grooves. The barrel is said to be wrought iron; over it is a layer of wrought-iron rings, and over these steel rings. The bore is closed by a screw plug, which, when withdrawn, can be turned round to the left, and a cup is used to prevent escape of gas. Two projectiles are shown, one pointed, for range, the other flat-headed, for penetration, and both have a lead ring round the shot near the base. The great advantage claimed for this gun is the amount of charge that can be usefully employed—viz., 24 oz. to 3 lbs. projectile; and it is asserted that at 30 deg. of elevation the shot ranged nine miles. It is, however, obvious, that the small diameter of the projectile ($1\frac{3}{4}$ in.) would account for a long range, and the immense amount of metal round such a small bore for the large charge. Three separate 1-in. plates are shown with penetrations said to have been produced by the flat headed shot at fifty yards' range.

Gatlin guns.

There is on each side of the Ferris gun one of the Gatlin batteries, which are neither pieces of ordnance nor portable arms; but as they are intended for employment as ordnance, and might in certain cases produce great execution, it is necessary to describe them. The Gatlin battery (Fig. 29) consists of a frame mounted on a gun-carriage, and supporting six steel barrels, which can be made to revolve, so as to bring each in turn opposite a chamber, by a handle at the side of a cylinder behind the chamber. In the cylinder is the mechanism for firing the cartridges, which is effected by the blow of a pin on a portion of detonating composition in the base of the cartridge; and an extractor advances as the barrels turn and withdraws the cartridge-cases. Twenty-five charges placed in a tin case drop one after another into the chamber through a gun-metal guide above. There are two sights—a hind and fore sight—so that each barrel when uppermost is laid on the object. The barrels of the larger Gatlin battery have a calibre of about an inch, and have six shallow grooves; those of the other a calibre of about half an inch and three grooves. The larger battery throws bullets of about $\frac{1}{2}$ lb., and the other bullets of $1\frac{1}{4}$ oz. The object of the battery is to fire a continuous stream of bullets towards the same point, and thus to supply more effectually the place of an ordinary gun throwing grape or case shot. The smaller battery which,

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with its carriage complete, weighs about 6 cwt., was tried at Washington, in January, 1866, against a target three metres square, at ranges of 100, 300, and 500 metres, when none of the bullets missed the target. Twenty rounds were fired in eight seconds. A Gatlin battery, tried at Fort Monroe against a 24-pounder howitzer, put 691 bullets into a target 48 ft. long and 6 ft. high, at a range of 150 yards, while the howitzer only put 89 balls into the target in the same time, $1\frac{1}{2}$ min.

The Gatlin battery is an improvement on the organ guns of the 16th century. The Federals, at the siege of Charleston, used a somewhat similar weapon, called a *requa* battery having 25 barrels, which, by means of a lever, might be diverged so as to scatter the balls according to the range, and General Gilmore reported that it was well adapted to the defence of earthworks.

The Gatlin battery was tried by the British Government at Shoeburyness, a short time ago, against a 9-pounder rifled gun, firing case shot; the ranges being 150 and 800 yards. At the former the general effect of the Gatlin bullets was superior to that produced by the case shot, except that the penetration of the bullets was but slight; but at 800 yards the case were far more effective than the bullets. Gatlin batteries, like other weapons constructed for continuous fire,

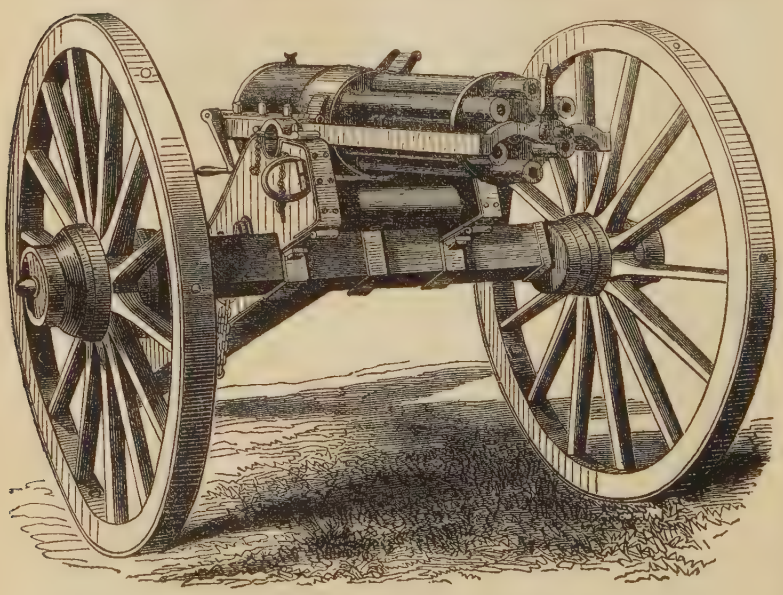

Fig. 29.—GATLIN BATTERY GUN.

might prove very formidable in the defence of short flanks, breeches, bridges, streets, or other confined situations, but can never supersede ordnance for ordinary war purposes.



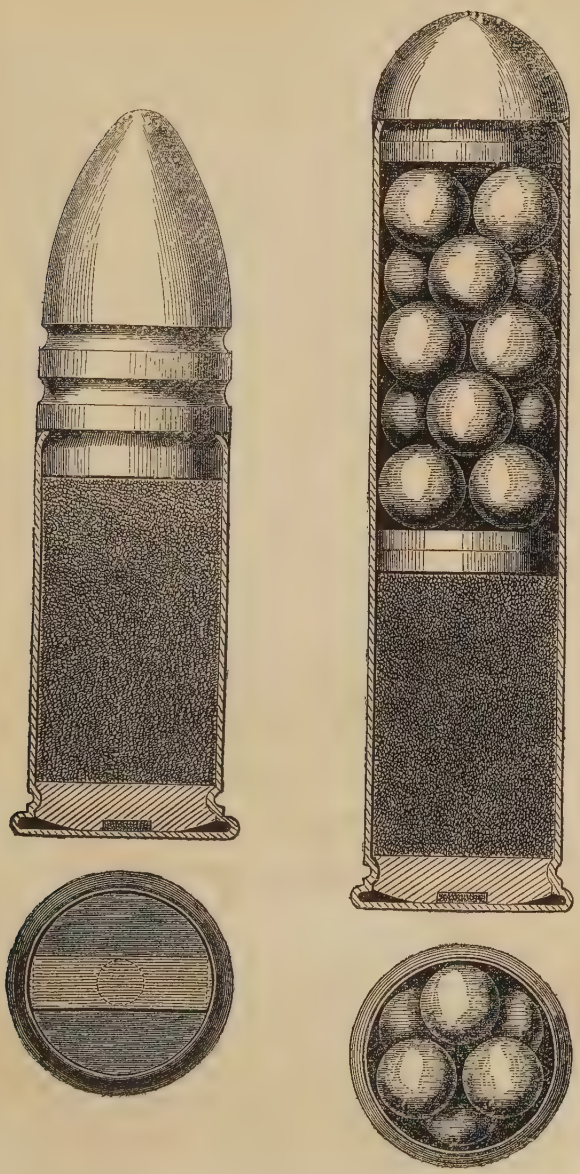

Fig. 30.—AMMUNITION FOR GATLIN BATTERY GUN.

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## Instruments for determining the Velocities of Projectiles.

Electro-ballistic instruments.

Several of such instruments are exhibited; but the limits of this report will only allow of a mere mention of them, which, however, will be sufficient to show that a considerable advance has been made in this direction since the last Exhibition. The ballistic and gun pendulums were employed to ascertain the velocities of projectiles; but within the last few years several instruments (Vignotti's, Navez's, Benton's, &c.) have been devised for applying electricity to the determination of these velocities. Of these, the instrument generally used has been the Navez electro-ballistic apparatus, and, more recently Colonel Leur's modification of it, consisting in the substitution of a simple mechanical arrangement in the pendulum for the conjunctor, which is not, therefore, required. One of Leur's instruments is shown in the Belgian department, and it may be here stated that the Leur's-Navez is now usually employed both in France and England for experimental purposes.

Only one velocity can, however, be taken at each round by any of the above instruments, and if the velocities at two or more points in the trajectory are required, additional instruments must be used. Now, no two instruments, even of similar construction, will probably give exactly the same results, and errors will therefore arise which, although of no great consequence in ordinary experiments, might be of importance if a number of velocities are wanted as data for the determination of the laws of the resistance of the air, or for other exact scientific questions. Two instruments of novel constructions are exhibited, both adapted to the determination of the velocities of projectiles at a number of different points in the same trajectory, and in both, the results of an experiment are recorded on a revolving cylinder; but these instruments are very different in other respects.

Schultz chronoscope.

One of these instruments, called the Schultz chronoscope, is the invention of Captain Schultz, of the French artillery, and is exhibited, carefully protected by a glass case, in the French department within the main building. The general principle of its action may be thus stated. A tuning-fork, making an ascertained number of vibrations per second, is arranged to trace on the blackened surface of a revolving cylinder a sinuous line, showing the beginning and end of each vibration. This sinuous line will be an actual scale of time. If, then, the instant the projectile reaches each of the the two given points in its trajectory be marked upon the cylinder beside the scale of time, the number of vibrations

between the two marks will give the time required. The principal parts of the instrument are the cylinder, vibrating fork, electric interrupter, Ruhmkorff coil, pendulum, and micrometer; and, while experimenting, the galvanic batteries and targets. A double motion of rotation and translation can be given to the cylinder by clockwork; on each side of the fork are two electro-magnets, to originate, sustain, and equalize its vibrations; and the left branch of the fork carries a quill-point, which marks the trace on the cylinder; the pendulum is used to determine the number of vibrations of the fork per second, which can, however, be determined by the pitch of the note sounded by the fork when struck; the micrometer magnifies the trace and fixes the position of the spark; and the targets are contrived so that after the rupture of one the current is transferred to the next before the projectile reaches it. This instrument* has been tried both in France and America.

Bashforth's chronoscope

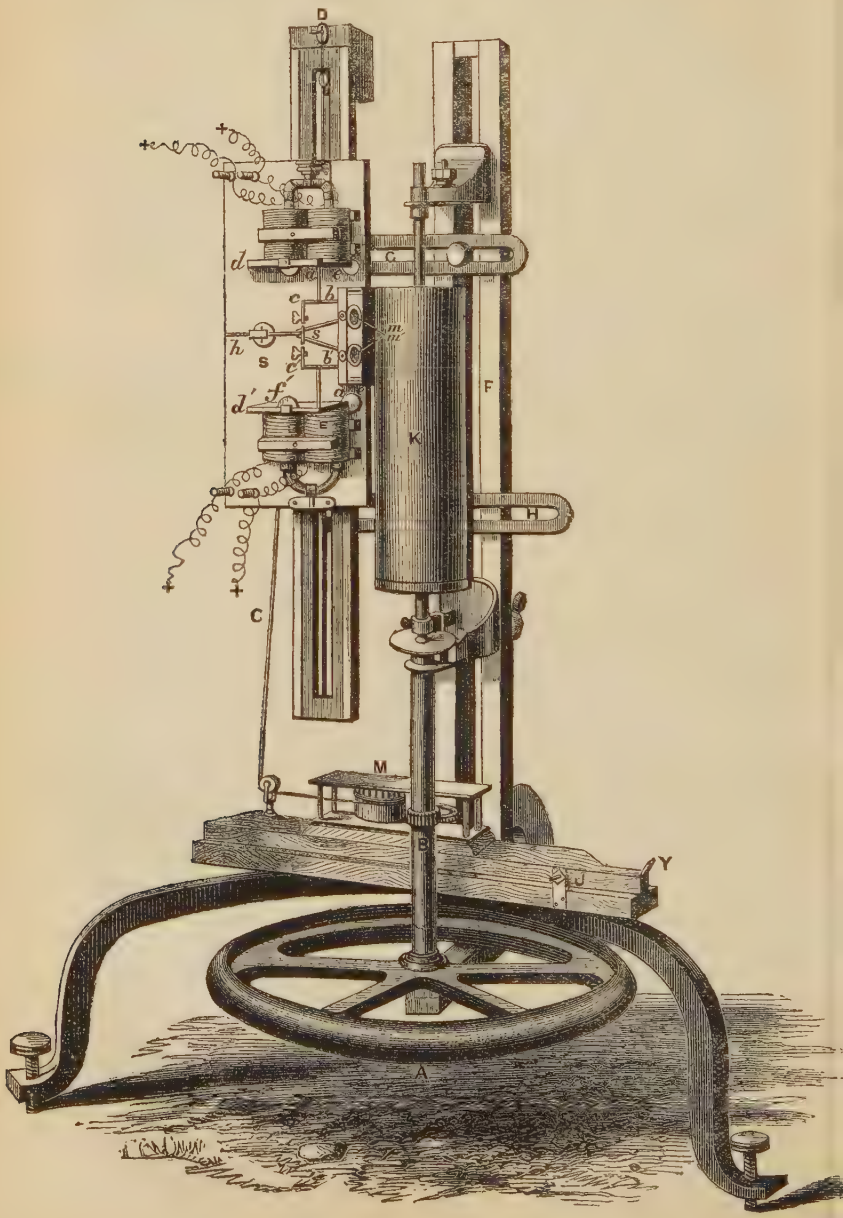
The other instrument, termed Bashforth's chronograph, is the invention of the Rev. F. Bashforth, Professor of Applied Mathematics to the advanced class of Artillery officers, Woolwich. It is to be found in the British Marine Department, but, as it has not been provided with a cover or protection of any kind, it is in a very unsatisfactory condition for inspection.

The following is a description† of the chronograph as constructed, and of various useful appendages. Fig. 31 gives a general view of the chronograph. *A* is a fly-wheel capable of revolving about a vertical axis, and carrying with it the cylinder *K*, which is covered with prepared paper for the reception of the clock and screen records. The length of the cylinder is 12 or 14 inches, and the diameter 4 inches. *B* is a toothed wheel which gears with the wheelwork *M* so as to allow the string *CD* to be slowly unwrapped from its drum. The other end of *CD* being attached to the platform *S* allows it to descend slowly along the slide *L*, about $\frac{1}{4}$ inch for each revolution of the cylinder. *E*, *E'* are electro-magnets; *d*, *d'* are frames supporting the keepers; and *f*, *f'* are the ends of the springs which act against the attraction of the electro-magnets. When the current is interrupted in one circuit, as *E*, the magnetism of the electro-magnet is destroyed, the spring *f* carries back the keeper, which by means of the arm *a* gives a blow to the lever *b*. Thus the marker *m* is made to

* It is described in a work on Electro-Ballistic Machines, by Lieut.-Colonel S. V. Benet, U.S.A.

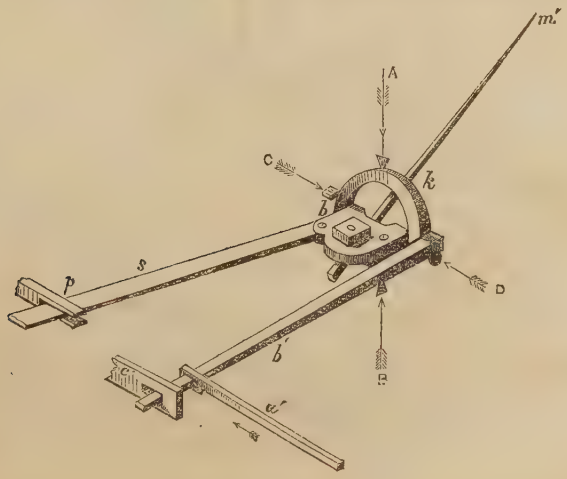
† From a pamphlet published by Mr. Bashforth, and printed in the Proceedings of R.A. Institution.

depart from the uniform spiral it was describing. When the current is restored the keeper is attracted, and thus the marker *m* is brought back, which continues to trace



its spiral as if nothing had happened. $E'$ is connected with the clock, and its marker $m'$ records the seconds. $E$ is connected with the screens, and records the passage of the shot through the screens. By comparing the marks made by $m$, $m'$ the exact velocity of the shot can be calculated at all points of its course. The slide $L$ is fixed parallel to $F$ and the cylinder $K$ by the brackets $G$, $H$. $Y$ is a screw for drawing back the wheelwork $M$, and $J$ a stop to regulate the distance between $M$ and $B$. The depression of the lever $h$ raises the two springs $s$, which act as levers, and bring the diamond points $m$, $m'$ down upon the paper. When an experiment is to be made, care is taken to see that the two currents are complete. The fly-wheel $A$ is set in motion by hand, so as to make about three revolutions in two seconds. The markers $m$, $m'$ are brought down upon the paper, and after four or five beats of the clock the signal to fire is given, so that in about ten seconds the experiment is completed, and the instrument is ready for another.

Fig. 32 gives a full-sized view of one of the markers, showing the way in which it is moved. The depression of the lever $h$ (Fig. 31), raises $p$, and thus the lever $s$, which is formed of watch-spring wire, brings down $m'$ to the paper, and keeps it gently in contact. This motion takes place within the circle $k$, about an axis $CD$. $a'$ is an arm connected with the electro-magnet. When the magnetism in $E'$ is destroyed, $a'$ begins to move away, and when it has moved a short distance it strikes the lever $b'$ a sudden blow which carries it as far as the hole in the stop $c'$ will allow it to move. The lever $b'$ is rigidly connected with the



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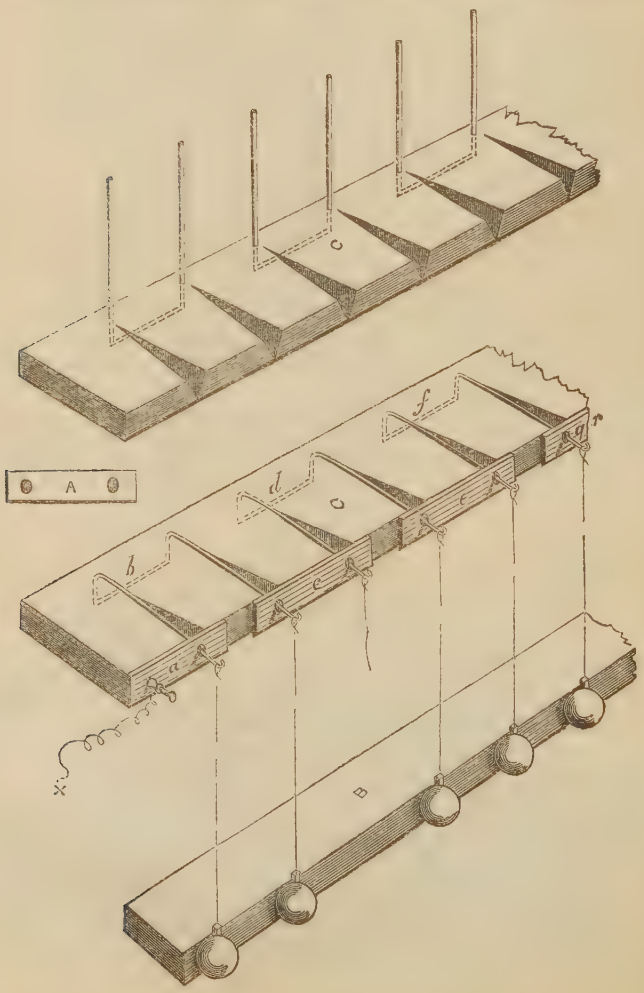
circle $k$, which is capable of moving about an axis $AB$. This motion is communicated to $m'$, which describes a very short arc of a circle about a point in $AB$. The arrangement is so made that when either of the markers $m$, $m'$ is making a record, it has a motion which may be resolved partly in direction of the motion of the paper under it, and partly in a direction perpendicular to this. Thus records are obtained which can be read off by scale with great nicety.

The pendulum of a half-seconds clock strikes once each double-beat a very light spring, and so interrupts the galvanic current in $E'$ once a second.

Figs. 33 and 34 give the details of the screens. Fig. 33 re-




Figs. 33 and 34.—SCREENS.

presents a piece of board 1 inch thick and 6 or 7 inches wide, and rather longer than the width of the screen to be formed. Transverse grooves are cut at equal distances, something less than the diameter of the shot, as shown in the diagram. Staples of hard brass spring-wire (No. 14 or 15), are fixed with their prongs in the continuation of the grooves. Pieces of sheet copper *A* are provided, having two elliptical holes, the distance of whose centres equals the distance of the grooves. The pieces of copper *A* are used to connect each wire staple, as *C*, with its neighbour on each side. Thus, Fig. 34, *a*, *c*, *e*, *g*, &c., represent these copper connexions put in their places and holding down the wire spring, which, when free, are in contact with the tops of the holes; but, when properly weighted, they rest on the lower edge of the holes. Thus the copper *c* forms a connexion between the staples *b* and *d*; the copper *e* joins *d* and *f*, and so on. A galvanic stream will therefore take the following course, whether the springs be weighed or unweighed: copper *a*, brass *b*, copper *c*, brass *d*, copper *e*, brass *f*, copper *g*, &c. The current will only be interrupted when one or more threads have been cut and the corresponding spring is flying from the bottom to the top of its hole. About $\frac{1}{50}$th of a second is required for the complete registration of such an interruption, the spring traversing about half an inch. The shelf *B* is placed for the weights to rest against, partly to prevent them from being carried forward by the shot, but chiefly to prevent the untwisting of the threads which support the weights. The weights used were about 2 lbs. each, and the strength of the sewing cotton for supporting them was equal to a stress of about 3 lbs., which was sufficient to withstand a tolerably strong wind. As the weights were equal the threads were kept equally stretched.

The arrangement of the screens for an experiment is shown in Fig. 35. The wires for conveying the galvanic current are like the common telegraph wire, carried on posts. *abc* is a continuous piece of wire; but there are interruptions between *e* and *h*, between *i* and *l*, between *m* and *p*, &c., in order to make the galvanic current circulate through the screens. The course of the galvanic current is + *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, *k*, *l*, *m*, *n*, *o*, *p*, *q*, *r*, *s*, *t*. The ends *a*, *t*, are connected with the instrument and battery. The shot, being fired, through the screens, in passing cuts one or more threads at each screen, so that corresponding to the instant at which the shot passes each screen there is an interruption of the galvanic current, and a simultaneous record on the paper.

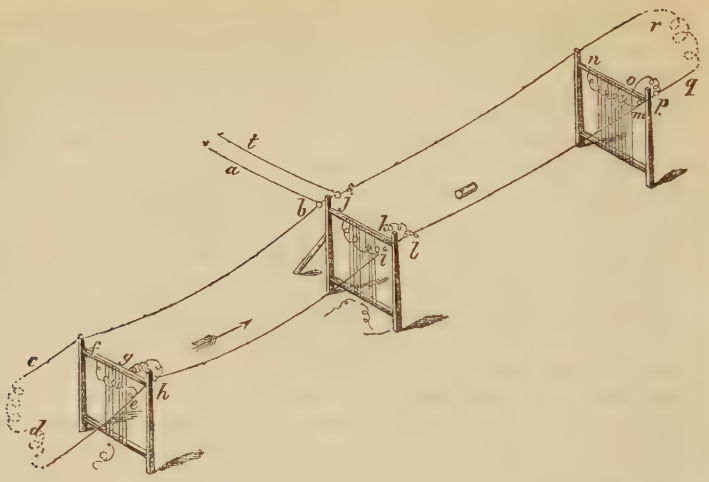



Fig. 35.—ARRANGEMENTS OF SCREENS.

When the cylinder is filled with spirals, that is after five or six shots, it is transferred to the instrument, Fig. 36, where *a* is a circle divided into 300 equal parts, and the division is carried to 3,000 by the help of a vernier. A small T-square, having a fine edge at *b*, moves along a brass straight edge *L*,

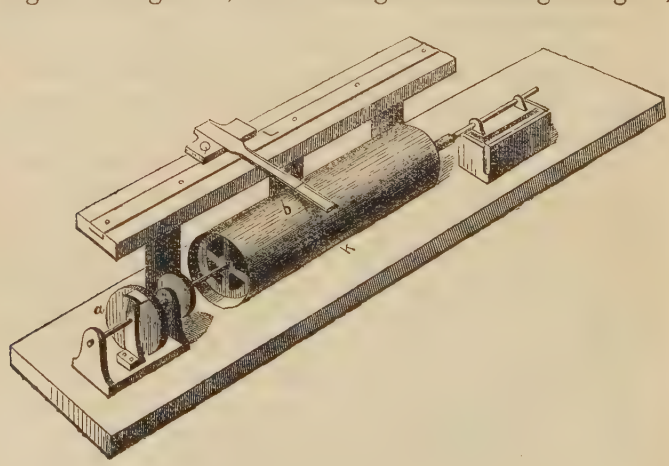



Fig. 36.—MEASUREMENT OF RECORDS.

adjusted so as to be parallel to the axis of the cylinder. The mark *b* is carefully placed opposite each record on the paper by means of a tangent screw (not shown in the figure), and the vernier is read.

The clock goes on breaking the galvanic circuit every swing of the pendulum, whether the marker $m$ be in contact with the paper or not—consequently, whatever be the loss of time in the action of the marker, we may fairly suppose it to be constant. But it has been objected that the current having been circulating through the screens for several seconds, or even minutes, without interruption before the shot is fired, the records at the first and the following screens are not made under the *same* conditions. A careful inspection of the results actually obtained showed that this objection had no foundation to rest upon for that particular experiment; still it seemed desirable to get rid of the objectionable arrangement lest an irregularity might make its appearance in some important experiment. The first screen was placed 120 feet from the gun, the second at 240 feet, and so on. One preparatory break would be obtained by placing a screen at the mouth of the gun; but in addition to this it appears well to introduce the ordinary self-acting contact breaker, made to beat as near as may be the intervals of time to be measured. The raising of a spring lever interrupts the main current of galvanism through the screens. The insertion of a pin to keep up the lever, re-opens a passage for the screen galvanic current through the contact breaker; this may be made also to ring a bell in the instrument room, to give notice that all things are ready for the experiment. The fly-wheel is then put in motion, the signal to fire is given; the pulling of the lanyard withdraws at once the pin, restores the main current, and fires the gun.

The following results of experiments made, in September 1866, to determine the resistance of the air to bolts having variously formed heads, will suffice to show the great value of the instrument. The ten rounds of hollow ogival shot (struck with a radius of 1 diameter) were remarkably successful. The gun was the 40-pr. M.L. The charge was 5 lbs. The average weight of shot was 21·81 lbs.

The experimental velocities given below are taken directly from group 11 of the Report dated October 1866. The calculated velocities are obtained from the formula $v = \frac{V}{1+2bsV}$, derived from a law of the resistance of the air, which varies as the cube of the velocity. The body is supposed to pass a point 150 ft. from the gun with a velocity $V$, and then $v$ is the velocity at the distance $s$ ft. In the report $bl^2$ is found = ·0012449 for this particular form and weight of shot, where $l = 150$ ft., which gives $2bl = ·000\ 016599$.

COMPARISON of Experimental and Calculated VELOCITIES.

| Round. | Distance from gun. | ft. 150 | ft. 300 | ft. 450 | ft. 600 | ft. 750 | ft. 900 | ft. 1050 | ft. 1200 | ft. 1350 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | f.s. | f.s. | f.s. | f.s. | f.s. | f.s. | f.s. | f.s. | f.s. |
| 14 | Exper. vel. | 1498·5 | 1462·0 | 1427·2 | 1392·8 | 1359·9 | 1331·0 | 1302·1 | 1275·5 | 1252·1 |
| | Calcul. vel. | 1498·5 | 1462·2 | 1427·5 | 1394·5 | 1363·0 | 1332·8 | 1304·0 | 1276·4 | 1250·0 |
| | Difference | 0·0 | −0·2 | −0·3 | −1·7 | −3·1 | −1·8 | −1·9 | −0·9 | +2·1 |
| 16 | Exper. vel. | 1521·3 | 1488·1 | 1453·5 | 1417·8 | 1383·8 | 1351·4 | 1320·4 | 1290·9 | 1262·6 |
| | Calcul. vel. | 1521·3 | 1483·9 | 1448·2 | 1414·2 | 1381·8 | 1350·8 | 1321·2 | 1292·9 | 1265·7 |
| | Difference | 0·0 | +4·2 | +5·3 | +3·6 | +2·0 | +0·6 | −0·8 | −2·0 | −3·1 |
| 18 | Exper. vel. | 1510·6 | 1473·5 | 1436·8 | 1403·2 | 1371·1 | 1339·3 | 1310·0 | 1281·0 | 1254·2 |
| | Calcul. vel. | 1510·6 | 1473·7 | 1438·5 | 1405·0 | 1373·0 | 1342·4 | 1313·1 | 1285·1 | 1258·3 |
| | Difference | 0·0 | −0·2 | −1·7 | −1·8 | −1·9 | −3·1 | −3·1 | −4·1 | −4·1 |
| 20 | Exper. vel. | 1515·2 | 1474·9 | 1438·2 | 1403·2 | 1372·4 | 1342·9 | 1314·6 | 1287·6 | 1262·6 |
| | Calcul. vel. | 1515·2 | 1478·0 | 1442·7 | 1408·9 | 1376·8 | 1346·0 | 1316·6 | 1288·5 | 1261·5 |
| | Difference | 0·0 | −3·1 | −4·5 | −5·7 | −4·4 | −3·1 | −2·0 | −0·9 | +1·1 |
| 22 | Exper. vel. | 1515·2 | 1482·2 | 1447·9 | 1415·1 | 1382·5 | 1352·6 | 1323·9 | 1294·2 | 1266·9 |
| | Calcul. vel. | 1515·2 | 1478·0 | 1442·7 | 1408·9 | 1376·8 | 1346·0 | 1316·6 | 1288·5 | 1261·5 |
| | Difference | 0·0 | +4·2 | +2·2 | +6·2 | +5·7 | +6·6 | +7·3 | +5·7 | +5·4 |
| 24 | Exper. vel. | 1507·5 | 1469·2 | 1435·4 | 1400·6 | 1368·6 | 1336·9 | 1307·8 | 1277·7 | 1251·0 |
| | Calcul. vel. | 1507·5 | 1470·7 | 1435·7 | 1402·3 | 1370·4 | 1339·9 | 1310·8 | 1282·9 | 1256·2 |
| | Difference | 0·0 | −1·5 | −0·3 | −1·7 | −1·8 | −3·0 | −3·0 | −5·2 | −5·2 |
| 26 | Exper. vel. | 1504·5 | 1464·8 | 1431·3 | 1398·0 | 1367·4 | 1335·7 | 1308·9 | 1283·2 | 1257·6 |
| | Calcul. vel. | 1504·5 | 1467·9 | 1433·0 | 1399·7 | 1367·9 | 1337·6 | 1308·5 | 1280·7 | 1254·1 |
| | Difference | 0·0 | −3·1 | −1·7 | −1·7 | −0·5 | −1·9 | +0·4 | +2·5 | +3·2 |
| 28 | Exper. vel. | 1513·6 | 1479·3 | 1443·7 | 1408·4 | 1377·4 | 1346·5 | 1315·8 | 1288·7 | 1262·6 |
| | Calcul. vel. | 1513·6 | 1476·5 | 1441·2 | 1407·6 | 1375·4 | 1344·8 | 1315·4 | 1287·3 | 1260·4 |
| | Difference | 0·0 | +2·8 | +2·5 | +0·8 | +2·0 | +1·7 | +0·4 | +1·4 | 2·2 |
| 30 | Exper. vel. | 1507·5 | 1472·0 | 1435·4 | 1400·6 | 1368·6 | 1338·1 | 1307·8 | 1281·0 | 1252·1 |
| | Calcul. vel. | 1507·5 | 1470·7 | 1435·7 | 1402·3 | 1370·4 | 1339·9 | 1310·8 | 1282·9 | 1256·2 |
| | Difference | 0·0 | +1·3 | −0·3 | −1·7 | −1·8 | −1·8 | −3·0 | −1·9 | −4·1 |
| 32 | Exper. vel. | 1447·9* | 1413·8 | 1381·2 | 1352·6 | 1325·1 | 1296·5 | 1268·0 | 1239·7 | 1212·6 |
| | Calcul. vel. | 1447·9 | 1413·9 | 1381·5 | 1350·6 | 1321·0 | 1292·6 | 1265·5 | 1239·5 | 1214·5 |
| | Difference | 0·0 | −0·1 | −0·3 | +2·0 | +4·1 | +3·9 | +2·5 | 0·2 | −1·9 |

* The low initial velocity was due to the gun having remained loaded all night—in all other respects this round is as good as the others.

Mr. Bashforth has made the following remarks on these experiments:—

"The hollow ogivals (of radii one and two diameters) were fired alternately, and at one period when the range

was clear the firing was so rapid that rounds 23—31 were fired in 45 minutes.

"Up to the present 79 rounds have been fired in connexion with the new chronograph. I put forward the above 10 out of the 79 rounds, as an example of what may be considered to be the limit of the powers of the chronograph, which I hardly expect to be equalled in future experiments.

"It has been pointed out to me that Professor Hélie announced in a work published in 1865 that he had made out that the law of the resistance of the air varied as the cube of the velocity, from experiments made at Gâvre in 1859, 1860, and 1861. It appears that this feat was accomplished by the help of some E. B. instrument, which required only two screens. As a comparison is suggested between these experiments and my own, I most willingly accept it.

"The French experiments, then, it appears, were spread over three years—1859, 1860, and 1861, but my own occupied only three days, Nov. 23 and 29, and Dec. 12, 1865. The number of rounds fired at Gâvre is not specified, but Hélie states, p. 408, '*Chaque vitesse* est déduite de 30 coups;' and again, p. 412, 'Les vitesses données par le canon No. 1 sont déduites de 48 coups. Les autres de 15.' At p. 443, 'Les vitesses des projectiles ont été mesurées à la distance de $33^m$, au moyen de l'appareil electro-balistique, les *moyennes prises sur* 60 *coups*. De là, on a déduit les valeurs des vitesses initiales.' In Woolwich Marshes the total number of rounds fired was 18. The Report to the Council, containing the law of resistance varying as the $(\text{vel.})^3$ was dated December 18, 1865, *i.e.* six days after the last shot, and twenty-eight days after the first shot was fired.

An important and extensive series of experiments are now being conducted at Shoeburyness to obtain with the Bashforth chronograph data for the determination of the laws of the resistance of the air to projectiles fired from rifled ordnance.

## Report on Portable Arms.—(Class 37.)—By Captain V. D. Majendie, R.A.

Capt. Majendie on Portable Arms.

The class of portable arms is very largely represented in this Exhibition. Out of the 33 countries, colonies, or states which contribute to the group (4) of "clothing" and other articles worn upon the person" the following 28 exhibit specimens of arms, of one sort or another, exclusive of artillery:—France, Algeria, Holland, Belgium, Prussia, and the northern German States, Bavaria, Austria, Switzerland, Spain, Greece, Denmark, Sweden, Norway, Italy, the Pontifical States, Turkey, Egypt, China, Loo-Choo, Siam, Tunis, United States of America, Brazil, the American republics, Hawai, the English colonies, and Great Britain. This list is arranged in the order in which the countries would be reached by a visitor who, entering the Exhibition at Porte Rapp and passing into gallery 4, turned to his left, and completed the circuit of the building.

Countries which exhibit portable arms.

It should be noticed, however, that, although by far the most important and interesting portion of the display of portable arms is disposed in this gallery, the whole of the arms exhibited will not be found here.

There are many interesting specimens of early weapons, for example, in the inner circle, where are grouped objects illustrative of the "Histoire du Travail."

The English arms of all sorts are in two sheds in the park, on the right-hand side entering from the Pont d'Iena. The military arms manufactured in the French Government establishments of Châtellerault and St. Etienne are placed with the other stores shown by the Ministère de la Guerre in a large shed outside the building.

The non-exhibiting countries in this class are Luxembourg, Hesse, Baden, Würtemberg, and Portugal.

The number of exhibitors in class 37 is very large, and although all those who are named in the catalogue have not exhibited the following list gives approximately the number of establishments which are represented:—

Number of exhibitors of portable arms.

| Country. | No. of Exhibitors according to Catalogue. | Country. | No. of Exhibitors according to Catalogue. |
|---|---|---|---|
| France | 98 | Prussia | 11 |
| Algeria | 11 | Bavaria | 3 |
| Holland | 8 | Austria | 17 |
| Belgium | 26 | Switzerland | 6 |

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| Country. | No. of Exhibitors according to Catalogue. | Country. | No. of Exhibitors according to Catalogue. |
|---|---|---|---|
| Spain | 10 | Siam | 1 |
| Greece | 2 | Tunis | 1 |
| Denmark | 1 | United States of America | 24 |
| Sweden | 7 | Brazil | 1 |
| Norway | 3 | American Republics | 2 |
| Russia | 21 | Hawaii | 1 |
| Italy | 31 | Great Britain and English Colonies | 34 |
| Pontifical States | 2 | | |
| Turkey | 102 | Total | 464 |
| Egypt | 37 | | |
| China | 1 | | |
| Loo-Choo | 3 | | |

Comprehensiveness of the collection.

Among so large a number of exhibitors it is reasonable to expect to find many objects of interest; this expectation will not be disappointed. The comprehensiveness of the collection is in itself a matter of the deepest interest. We find that it includes types of almost every conceivable variety of arm, from the stone and flint arrow-heads of the remotest periods of the world's history to the latest and most ingenious developments of breech-loading fire-arms. There are the rude clubs and maces of aboriginal tribes for hand-to-hand warfare; and there are rifles which will shoot accurately over a range of 2,000 yards. There are little toy pistols, so small that the trigger must be pulled with the finger nail; and there are the great duck and whale guns, which almost pass beyond the limits of portable arms. There are weapons, too, of every variety of price, from the single-barrelled Liège *armes de commerce*, at 6½f., up to the almost priceless *armes de luxe*, which are a specialité of the French gun trade. There are pistols from 2½f. to 10,000f.; there are swords from 3f. to 30,000f. We find weapons of every degree of finish and of surprising novelty of construction, such, for example, as a gun containing in the stock a small electric apparatus by which it is discharged (exhibited by MM. Le Baron and Delmas, in the French court; while, on the other hand, weapons of the rudest and most obsolete make are fully represented.

Salient features in the history of hand and portable arms.

It would be possible, no doubt, and perhaps interesting, to trace in this Exhibition each gradation and development of the kindred arts of war and the chase, as illustrated by the various specimens of sporting and warlike appliances of different periods and countries. To do this exhaustively would involve labour of no common order, and would be to

some extent foreign to the object with which this report is compiled. But without attempting to go so far as this, and without losing sight of the object of the report, it may give a certain connexion to the subject, and lead visitors to regard the different typical specimens with more interest and attention than they might otherwise care to bestow upon them, if we mark the salient features in the history of hand arms, and note the various epochs of progress which have furnished us with new types.

1st Epoch. (Natural weapons.)

It may reasonably be assumed, of course, that man first attacked his enemy or his prey with the natural weapons with which nature had provided him; that he fought after his animal instinct, as animals fight now. This would be the theoretical commencement of human warfare, whether against his own or the beast kind; but practically man's intelligence must early, if not immediately, have made evident to him the advantages to be derived from the employment of auxiliary means of warfare, weighting his fist with a stone, striking with a stick or club, or thrusting with a spear. Gradually these instruments came to be fashioned in the forms and of the materials which the nature of their employment or the circumstances of the country recommended; and hand arms, or side arms, as they are now generally called, thus assumed in time a definite character and a recognized importance. Their construction and use became methodised, as it were, the weapons thenceforth advancing towards perfection, or remaining sometimes in their condition of rude primitive inefficiency, according to the means of the country and the intelligence and aptitude and needs of the inhabitants. The materials employed for these weapons have been such as could be most easily procured and most readily fabricated. Thus we find in some countries that the maces, spears, clubs, and javelins are made entirely of wood, and there are nations or tribes which have not yet got beyond wooden weapons to this day. Specimens of arms of this class are to be found in the Victorian, New South Wales, and Queensland collections, among the arms from the Cape of Good Hope, Hayti, and among those exhibited as being used by the Indians of North America. Other examples, doubtless, exist among the trophies of African, East and West Indian, and other aboriginal arms which are exhibited by France, Algiers, Holland, and Siam, but which it seemed unnecessary carefully to search out.

2nd Epoch. (Auxiliary weapons.)

3rd Epoch. (Hand, or side arms.)

Wooden weapons.

Of weapons made of other simple materials, of stone and

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Stone and flint weapons.

flint, we find examples, together with bronze swords and spear heads illustrative of the drift and bronze periods, in the "Histoire du Travail." This circle is extremely interesting, but at the time we visited it it was very far from being complete. Not only does the "Histoire du Travail" form a fitting starting point in an examination of the different arms, but it furnishes instructive examples, as we shall presently have occasion more particularly to notice, of the great antiquity of inventions which are often presented as absolute novelties.

Iron and steel weapons.

Diminished importance of side arms.

Passing beyond these rude hand-weapons of wood and stone and bronze, we get to iron and steel swords and spear heads and knives and daggers. And here we find ourselves on the track which leads directly down to our own age. It is impossible not to feel that the interest which has hitherto attached to this class of arms has in a great measure departed since the general adoption of breech-loading rifles. We would not be misunderstood as expressing an opinion that side-arms will be no longer useful; but it is impossible to shut one's eyes to the fact that each successive improvement in fire-arms has tended to reduce proportionally the military importance of the sword and lance and bayonet; and that the introduction of a system by which the rate of fire of soldiers is multiplied four or five times must prove a serious blow to the practical value of this class of weapon. The occasions must henceforth be comparatively rare in which hand-to-hand contests will be possible: rarer still in which whole regiments, whether of infantry or cavalry, can come to close quarters; and these considerations must inevitably influence, sooner or later, the destiny and importance of arms specially intended for close fighting. This opinion, indeed, finds practical expression in a bayonet exhibited among the English arms by Mr. Scott Tucker. This bayonet is scarcely half the length of the present bayonet, and Mr. Scott Tucker suggests its adoption on the distinct ground of "the chance of crossing "bayonets being materially lessened by the introduction "of breech-loaders." He claims for it the advantages of being comparatively light, cheap, strong, handy to draw and return, less easily parried, quick for thrust and withdrawal, free from chance of locking, and out of the way when skirmishing. However opinions may differ as to the desirability of modifying the existing bayonet, this deliberate recognition of a new order of things is not without its significance.

But, apart from the question of their relative importance, the side-arms deserve to receive attention on account of having attained the highest development which they are likely to teach, as having touched in this Exhibition the maximum of excellence, whether of workmanship or richness of ornamentation, which it seems possible for them to achieve. Moreover, the exceeding variety of swords and spears and lances and hand-weapons of all sorts exhibited is very striking, and might well furnish matter for a separate study.

High finish attained by side arms at the present time, as exhibited in the Paris collection.

Considered as weapons, and distinguished from mere state swords and *armes de luxe*, the exhibition of Solingen swords, though small, is probably the most valuable in the Exhibition. The very high character of the Solingen blades secured for this town in 1855 the *grande medaille d'honneur*, and, as far as one may judge without exhaustive experiments, the swords shown in the present Exhibition are not less worthy of distinction. Although there is only one exhibitor of Solingen swords (M. Carl Reinh Kirschbaum), Solingen blades will be found all over the Exhibition. Nearly all the Continental nations use them, mounting them, as may suit the required service or best satisfy the taste of their countrymen or customers, with plain or richly-ornamented hilts and scabbards of various patterns. M. Kirschbaum's display is not remarkable for high decoration. It is composed mainly of regulation swords for the different armies of Europe. The cheapness of the Solingen swords is, next to their excellence, a point which deserves notice. An English infantry officer's regulation-sword, with steel scabbard may be obtained wholesale for 22f.; retail probably for about 1*l*. The French Line officer's sword cost, wholesale, 24f.

Solingen swords.

Their superior quality and exceeding cheapness.

The process by which the Solingen makers impart to their sword blades a gilding of peculiar permanence is said to be a secret.

Solingen prefers, on the whole, cast-steel to Damascene blades, although she excels in swords of both sorts. The makers are inclined to think that the introduction of the iron necessary to produce the damascened appearance is apt to soften the sword to some extent and to interfere with the high character of the blade; on this subject, however, it is well to notice that great stress is laid by the Solingen makers on the "return" of a sword after bending. The power which a blade may have of straightening again is accepted by them almost as a crucial test of its excellence; and when a sword is bent to a point beyond which it can

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return perfectly straight they would almost prefer it to break than that it should exhibit softness and remain crooked. Sword-makers, however, are far from agreeing on this point. It is argued that, although it is well that a sword should straighten, it is better that it should remain permanently bent than that it should break, a bent sword being more serviceable than a broken one; and the Solingen makers are considered to lay undue stress upon the straightening qualities of the sword. As, however, the flexibility of a blade depends, after its quality, upon its transverse section, and as Solingen exhibits swords which will bend almost round a man's body, it would seem as though all the flexibility that could possibly be desired can be obtained without any admixture of iron. When a Solingen maker says he prefers if his sword be bent beyond what it is capable of standing that it should break to remaining crooked, the burden of proof rests upon others of showing what useful purpose would be served by making a blade capable of being bent further at the expense of some softness.

Swedish swords.

Some fine blades are exhibited by Svengren in the Swedish Court. They are both damascened and plain, and are of low price, although a little in excess of the Solingen blades.

Spanish swords.

The Spanish Government exhibits a complete collection of the swords and sabres used by the officers and officials in that country; also of lances, axes, &c., which are manufactured at the celebrated factory at Toledo.

The peculiarity of the Toledo sword blade is that, with the object of producing the flexibility to which Spanish makers attach so much importance, they are formed of a hearting of iron cased with steel. These blades are no longer held in the same esteem as they formerly were, and the price is double that of the cast steel blades of Solingen.

Of the private manufacturers, Jean Martin of Madrid shows the best case. The prices of officers' swords vary from 16 to 100 escudos (1*l.* 13*s.* 6*d.* to 10*l.* 10*s.* of English money).

French swords.

The case of MM. Delacour and Backes in the French armoury contains perhaps one of the most striking collections of swords in the Exhibition, and to the mass of visitors will perhaps prove even more attractive than the Solingen blades on account of the magnificence of the ornamentation. The ornamentation may in some instances be regarded as excessive, but it is sufficiently various to meet all tastes,

and the designs are often exquisitely graceful and pure. The most expensive sword exhibited by this firm is a jewelled sword for India, and priced at 30,000f. The cheapest sword exhibited is a dummy weapon worn by the "pompiers," at 3f.



Application of aluminum to sword making.

Messrs. Delacour prefer for hot climates silver-plated scabbards, as they do not rust so readily with the touch of a hot hand as the steel scabbards. They show a sword with the hilt and scabbard of aluminium. This application of aluminium is exhibited rather as a curiosity than with any idea of its general adoption. The exceeding lightness of the material would be a recommendation; but its cost, and the fact that it will not take a high polish, and, finally, the extreme susceptibility of the surface to scratches, place the employment of aluminium for sword scabbards out of the question.

There is no special novelty in the application of fish and serpent skin to sword scabbards, but Messrs. W. Delacour employ these skins very effectively in some handsome swords. Another case of handsome swords and *couteaux de chasse* is by M. Spiguel.

Examples of highly ornamented swords of different sorts are to be found also in the cases of many of the French gunmakers. M. Thomas, for example, M. Houllier-Blanchard, Le Page, Moutier, Faure, and others exhibit specimens, which, however, beyond the degree of taste shown in the ornamentation and the occasional fine reproduction of ancient work, possess no particular features of novelty or interest. With a view to improving the tracery of the Damascene blades, some of the French makers work up steel, bismuth, nickel, and platinum. The *couteaux de chasse* in the French Court are often worthy of notice as works of art.

Sword revolvers.

A noticeable novelty, which is exhibited by Lafaucheux, and of which specimens are to be found in the cases of Le Page and Chauvot, and other Liège makers, and in the Italian collection is a sword with a revolving pistol in the hilt. The pistol is so arranged that the trigger falls within the sword guard, and the fire is delivered parallel to the blade of the sword. These revolvers, which are said to be used by the officers of the Italian army in large numbers, are invariably adapted for copper cartridges, containing their own ignition, either pin or central fire.

Italian swords. Chinese swords.

Several highly ornamented Indian and Chinese swords are exhibited. For the latter is specially claimed excellence of blades. The Indian collection is well worthy of inspec-

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tion, the Maharajahs of Indore, Gwalior, Jyepore, the Chief of Cherkhare, Baonee, Jhailar, Punwah, &c., being amongst the exhibitors. The Indian arms vie with, and in some instances surpass, the French in beauty and elaboration of ornament.

Algerian arms.

Algeria exhibits a trophy of portable arms, including several handsome swords and a few spears and arrows. The other French colonies on the west coast of Africa exhibit specimens of native weapons, among which is noticeable a knife for human sacrifices.

Arab swords.

Egypt has a few Arab swords of rude workmanship.

Turkish swords.

The Turkish collection of swords, which are generally highly ornamented, is interesting, including examples of the sabres, yataghans, spears, daggers, &c., in use in different parts of the Ottoman empire. Among the sword blades are some good examples of Damascene work. We may instance those exhibited by Hadji Ahmed Agha, of Constantinople.

Tunisian swords.

One or two of the jewelled Tunisian swords are worthy of notice.

Austrian swords.

In the Austrian Court Würzer exhibits a few swords and *couteaux de chasse*. Beyond their cheapness, these arms possess no special interest. The cheapest sword exhibited is priced at $8\frac{3}{4}$ f., and the regulation infantry officer's sword costs 22 f. We had no means of determining the quality of the blades.

Russian swords.

The Russian collection includes specimens of sword blades. The lowest price blade is 2 roubles 90 copecks (about $11\frac{1}{2}$ f.)

The collection of trenchant arms completes the class of arms employed by man in hand-to-hand encounters.

4th Epoch. (Projectile weapons.)

We pass next to projectile weapons. Of these there are many varieties, viz., from the javelins, assegais, djerids, and other missile weapons intended to be thrown by hand (of which examples are to be found in the Cape Town, Natal, Australian, Victorian, Haytian, American Indian, Turkish, and East Indian collections); to the arrows intended to be projected from a blowpipe, of which poisoned specimens, with the blowpipe, are shown among the exhibits of British Guiana and Equador; arrows designed for use in long and cross bows, and exhibited in the North and South American, the Paraguayan, the Egyptian, Algerian, and various African collections. We were unable to discover in the Exhibition any specimens of a sling, which would naturally belong to the group of weapons which we are considering. These weapons are interesting rather as

5th Epoch. (Fire-arms.)

curiosities, or as exhibiting the backwardness of the art of war among those people, who, like some of the American Indians and most of the indigenous African tribes, have not yet generally adopted fire-arms. Considered as a group, this class of weapons is interesting also as furnishing the connecting link between hand and fire-arms.

General absence of body armour where fire-arms are in vogue.

It is at this point also that we mark the almost total disappearance of body-armour. Where fire-arms have generally come in, body-armour has generally disappeared; while among those races who still depend to any extent upon the spear and sword and bow in their contests it is still retained. The finest collection of armour is that exhibited in the East Indian Court. Some examples of armour made of deer skin and shield of rhinoceros hide, said to be bullet proof, are shown by the Maharajah of Indore and others, in addition to fine mail suits and handsome shields. Shields are generally to be found among the nations which we have enumerated as exhibiting spears, arrows, &c., and, indeed, may be regarded as a sort of natural complement of this class of arms. In speaking of body armour as having generally disappeared from use in those countries where fire-arms are the principal weapons, we ought not to omit to notice the retention of cuirasses for our own Life Guards and for the cuirassiers of France and Austria. These articles, so called, of defence must, however, be regarded as out of place in modern civilized warfare, and their retention in the nineteenth century is altogether anomalous.

6th Epoch. (Fire-arms of precision.)

The distance at which projectiles thrown by the hand, by the blow-pipe, by the sling, or by the bow, permitted the soldier or the sportsman to engage, was exceedingly limited, and their accuracy, even within these ranges, was comparatively small. It was in these two directions principally in which the introduction of fire-arms was destined to effect important improvements. It increased enormously both the range and accuracy—in other words, the general effectiveness of arms.

One of the points dwelt upon by Captain Fowke, in his report upon the small arms of 1855, was the perfection which they had attained as long range arms of precision. The decided advance made by Thierry, Delvigne, Thouvenin, and Minié, had borne fruit in 1855 and the few years preceding in the almost universal adoption for military purposes of the elongated rifle bullet. And we can point to no change since this time, bearing upon the range and accuracy of small arms, so important as the introduction of the conical gas-expanded bullet. In this respect the present

No remarkable and special improvement in accuracy of fire-arms

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Exhibition marks no epoch of progress, as the 1855 Exhibition may be said to have done; though, as we shall presently see, a change of another sort and of no less importance has been effected in the interval. There have also been introduced an infinite variety of small improvements, designed further to extend the range and improve the shooting — changes such as the substitution of a wood, and afterwards of a clay plug for the Minié iron cup; a better adjustment of the relation of pitch, calibre, and windage, such as has been worked out by Mr. Whitworth; more careful workmanship, improvements in powder; more matured constructions of bullets for different calibres, in some of which the expanding agent is omitted altogether; and various smaller refinements, which, together, have combined to place in the Exhibition of 1867 arms which for long range shooting and accuracy go far beyond all the conceptions of 1855. We may instance as salient examples of this class Mr. Whitworth's celebrated match rifles (of which one or two specimens are shown), which for accuracy have never been surpassed; and the rifle exhibited by Mr. Metford, as having won the rifle matches in 1865–6 at the extraordinary range of 2,000 yards. Military and sporting rifles generally, foreign as well as English, are now required to possess a degree of accuracy and range far above the average requirements of 1855.

such as characterized the former Paris Exhibition. Although a sensible augmentation of accuracy is noticeable due to a variety of small improvements.

With the exception of the military rifles exhibited by Belgium and America, the English collection of *rifles*, though small, is perhaps the most important in the Exhibition.

English fire-arms conspicuous for exceeding accuracy and high character of workmanship.

It has been one of the special tendencies of the English volunteer prize-shooting system to foster the production of long range arms of precision; and the amount of large game shooting among English officers in India has served at the same time to correct this disposition, or rather to balance it, by giving us rifles of great power, intended to project large spherical balls with a low trajectory. Thus, side by side with the arms we have mentioned, we find the lockfast rifles of Mr. Dougall and the powerful sporting rifles of Mr. Lang and Mr. Reilly. The English collection of guns in this way includes the extreme types of rifles—the long range small bore rifle for projecting an elongated bullet with a *precision de luxe*, if we may employ the term, and the large bore sporting rifle, of great power and accuracy for short ranges.

The English military rifles, which lie midway between these extremes, combining many of the advantages of both,

also exhibit a marked superiority over those of other countries, and we search in vain in this Exhibition for samples of military arms of the same finish and of the same known powers as those shown by the Royal Small Arms Factory at Enfield.

Fire-arms considered as arms of precision, attain their highest development in England.

We see, then, fire-arms, considered as arms of precision, attaining their highest development in England. But fire-arms have to be considered otherwise than as mere arms of precision. To say nothing of the large group of smooth bore sporting guns, the finish, balance, and ease of shooting of which form important features, there is a point beyond which nothing of practical utility remains to be accomplished in the matter of range and accuracy. The line has been drawn in England considerably in advance of the standard imposed on the Continent; but wherever that line be drawn there is the point beyond which it is practically useless to travel, and when this point is reached men turn instinctively to the improvement of small arms in another direction.

7th Epoch. (Breech-loading fire-arms.) Object of breech-loaders is multiplication of rate of fire, and facilitation of delivery, not extension of range or accuracy.

The object naturally to be striven after when the requirements of range and accuracy have been fully satisfied is the multiplication of the rate of fire and the facilitation of its delivery; and the development of fire-arms as arms of precision having reached within the last decade its limit of practical utility, we find the instructive desire to effect an improvement in the direction which we have indicated, bearing fruit in the substitution of breech-loading for muzzle-loading. By such substitution the object sought can be obtained in a larger degree than by any other means, and the characteristic feature of the present collection of fire-arms is the very general adoption of breech-loading for all small arms.

It is true that in 1855 breech-loading had been largely applied on the Continent to sporting guns, but it had then not been applied to any considerable extent (except in Prussia) to rifles, either for military or sporting purposes; and it was at this period almost unknown in England for arms of all sorts, except, perhaps, revolvers.

These facts are explicable, no doubt, by the problem of the application of breech-loading being so much easier in connexion with sporting guns than with rifles, where the strain upon the breech action or cartridge is necessarily greater; while there were reasons, which it would occupy too much space to detail, for hesitating about the adoption of breech-loading for military purposes.

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Thus the chief interest and importance of the present exhibition of small arms are derived from the fact that it is the first exhibition in which breech-loading has been accepted as a universal principle.

The salient feature in present exhibition of fire-arms is the general introduction of breech-loaders, to the almost total exclusion of muzzle-loaders.

As in 1855 we had the fruits of the then recent improvements in fire-arms considered as arms of precision—and as accuracy at long ranges was the one prevailing idea, the groove in which men were working at that time—so now, in 1867, the display of fire-arms gives us the material results of the recent breech-loading movement. It may not, perhaps, be literally correct to say that all small-arms are now breech-loaders, or even that they are being converted to breech-loaders as fast as time and means will permit, but substantially this statement would be accurate. Whether for sporting guns, for rifles of all sorts, or for pistols, breech-loaders are now the accepted type.

There is something noticeable in the way in which the nations, as one, have sprung to this conclusion. The barriers of ignorance and conservatism and suspicion within which this branch of the subject has been confined have been broken down, as it seems, almost in a few months all over the world.

England almost only exhibitor of muzzle-loading fire-arms.

Almost the only important country which shows muzzle-loading arms of any sort is England, viz., the Whitworth, Metford, Reilly, and other rifles used by our volunteers for match-shooting. It is to be regretted that our finest examples of arms of precision should be in this respect so far behind the age, although match-shooting is undoubtedly the occasion on which the advantages of breech-loading are least sensible.

Principal English exhibitors of fire-arms, ammunition, and kindred appliances.

The English display of arms is, on the whole, meagre. With the exception of the collection of arms shown by the English Government, Messrs. Reilly's case is the only one in which an attempt has been made to exhibit in a manner worthy of the class and of the position of the English gun trade. Messrs. Reilly have a number of sporting rifles of different sorts, the best being made on the central-fire system.

They exhibit, also, a needle-fire double-barrelled gun adapted for a cartridge with a tin base and paper body. The body is consumed by the discharge, the tin base must be withdrawn. Messrs. Reilly have a few military rifles; some revolving pistols, the majority of which are adapted for very small rim-fire copper cartridges, two air-canes, and a few saloon pistols.

This firm have adopted a brass chamber, fitted with a nipple, for use with breech-loading guns, when, in the absence of proper ammunition, it is desired to use loose powder and percussion-caps.

The pin-fire guns exhibited by Messrs. Reilly range in price from the low sum of 10*l.* upwards; the central-fire guns are of finer quality and more expensive, ranging from 30*l.* upwards.

Mr. Lancaster shows a few guns, the most noticeable feature of which is that in the central-fire guns the piston-spring is got rid of and the piston is hinged on to the lock with which it acts.

Mr. Lang exhibits several guns and rifles, among which are some good examples of the snap action system. He claims as a novelty his method of extraction in central-fire guns, by which the extractor is dependent only upon a simple mechanical arrangement for its working, and is not closed, as in many guns, by pressing against the breech of the gun on the return of the barrels. Mr. Lang states that he is now getting rid of the piston spring, a point to which we attach some importance; but, as he has no guns so arranged in the Exhibition, we are unable to express any opinion as to the merits of the plan which he proposes.

Like Messrs. Reilly, Mr. Lang has adopted a moveable chamber for use with guns on an emergency. But Mr. Lang makes his chamber of steel, instead of brass. He covers the chamber externally with paper, and states that in this way all escape down the outside of the chamber is effectually prevented. Mr. Lang has a fine example of a powerful breech-loading sporting rifle, designed for throwing a $1\frac{1}{2}$-oz. spherical, or a $2\frac{1}{2}$-oz. conical ball, with a low trajectory for short ranges.

Mr. Whitworth's rifles have been already mentioned. He states that he now entirely obviates fouling in small bore by attaching to the base of his bullet two thin copper plates with a lubricant between them. The system is similar to that applied by Colonel Boxer to the Armstrong gun. Mr. Whitworth exhibits a pair of steel double barrels, which he states were made in one piece. As one of the objections to the employment of steel for double-barrelled guns consists in the uncertain alteration which the steel undergoes in the process of brazing the barrels together, this manufacture of the two barrels in one has some importance.

Messrs. Colt exhibit a case of revolving pistols and rifles. These arms possess no special novelty, and, indeed, are

Revolving pistols and rifles.

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English collection of these arms behind the age.

behind the age, in so far as they are none of them adapted for cartridges containing their own ignition; while on the Continent capping revolvers are as much out of date as muzzle-loading guns. Messrs. Colt have, in some instances, fitted moveable stocks to their pistols. If they would go a step further and adopt their pistols for self-igniting cartridges these stocked revolvers might serve as useful arms for yeomanry regiments and various mounted corps. *

Jointed gun stock.

An arm called the "Cheltenham rifle, Jones's patent," is exhibited in the English shed. The novelty consists in the construction of the stock, which is jointed so as to permit of the upper part being moved, thus altering the inclination of the stock to the barrel according to the range, and obviating the difficulty which is experienced in firing at high elevations, in consequence of the bend of the stocks remaining fixed and uniform at all ranges.

Mr. Jones claims for his invention that it affords special facilities for competitive shooting at long ranges.

"Lock-fast action."

Mr. Dougall, of St. James's Street, shows a case of guns and rifles. The principal feature in his arms is the principle of "lock-fast" breech closing, with which his name is generally associated. The cylindrical hinge upon which the barrels turn in the ordinary Lefacheux guns is made by Mr. Dougall, an eccentric rod which draws back the barrels longitudinally, directly upon the bevelled face of the false breech, instead of the two merely meeting as flat surfaces, and barrel and breech become thus interlocked, the interlocking being made more complete by a projecting pin under the barrel and two projecting discs on the false breech.

By this system great strength of breech is obtained, and very heavy charges can be fired without that dipping of the barrels to which the Lefaucheux guns fired under such circumstances are sometimes liable. The arrangements would seem to afford more strength than is required for ordinary sporting guns, and with a certain sacrifice of rapidity. Much of the value of the system must depend also upon its durability and absence of wear; but upon this point Mr. Dougall assures us his testimonials leave nothing

* Since this report was prepared a general disposition towards breech-loading revolvers has sprung up in this country. Several papers have advocated the supersession of the capping or nipple revolver by a revolver adapted to a cartridge containing its own ignition; and the Government have recently adopted a breech-loading revolver submitted by Messrs. Adams, with a metallic central fire cartridge, designed by Colonel Boxer, R.A.

to be desired, and the system is undoubtedly regarded with favour by many sportsmen.

Mr. Greener exhibits a case of guns, among which is prominent his harpoon gun for killing whales.

Military arms exhibited by English Government.

The Government display of small-arms is very complete and well arranged. It was prepared at the Royal Small Arms Factory, at Enfield. The various service arms converted on the Snider system are shown, and include the long Enfield of 1853, the short Enfield of 1858 (naval) and 1860 (serjeants' and rifle regiments) patterns respectively; the artillery carbine of 1861, the cavalry pattern 1861, and the Lancaster patent oval-bore carbine used by the Royal Engineers. Patterns of the same arms are exhibited also as muzzle-loaders. Westley Richards's breech-loading carbines are exhibited, but we notice that neither Sharp's nor Terry's breech-loaders, which are both to a limited extent in the hands of regiments, are included in the collection.

Colt's and Deane and Adams's revolving pistols are shown, of the patterns issued to the service; also two muzzle-loading rifle pistols, patterns 1860 and 1861 for cavalry, of which the former is fitted with a moveable butt for yeomanry. We thus mark in the British service three sorts of breech-loading as actually in existence, viz., Snider, Westley Richards, and for pistols, a revolving action. To this, as we have pointed out, Sharp's and Terry's breech-loaders might be added.

The processes of manufacture of the barrel, stock, bayonet, sights, and parts of the lock are exhibited, and are well worthy of inspection. Examples of the various service swords, twelve different patterns in all, are shown, together with lances, foils, and Life Guards' cuirasses.

The Royal Laboratory case, which stands close by, forms a fitting supplement to the Enfield case, including, as it does, specimens of the ammunitions for the different patterns of arms exhibited, together with percussion caps, barrels for packing ammunition, and other appliances connected with small-arms.

English cartridges have only one representative, Mr. Ludlow, of Birmingham, who has a small case of different patterns for capping and non-capping arms.

Samples of the best-known varieties of military and sporting cartridges, with the exception of those for rim-fire guns, are exhibited.

In comparison with the fine cases of Gevelot, Gaupillat, and Chaudin, of Paris, this show of English cartridges is

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exceedingly insignificant; but it is, perhaps, in keeping with the rest of the English display in class 37.

Instrument for ascertaining distances.

As belonging to this class, we may mention an instrument exhibited by Lord R. Pelham Clinton for ascertaining distances. "The principle of this instrument is that when "a telescope is directed to any object, that object is photo- "graphed in the focus of the object-glass of the telescope, "the size of which photograph is proportionate to the "distance of the object."

Gun cotton.

Although gun-cotton is in itself no novelty, the method of applying it which Messrs. Prentice, of Stowmarket, have adopted is quite new. This firm exhibit a small but exceedingly interesting case of gun-cotton for various purposes, the principal features of the display being that the whole of the cotton, whether for mining, sporting, or military purposes, is prepared on the system devised by Professor Avel. In this system the gun-cotton, which has previously been prepared on a close imitation of Von Lenk's process, is reduced to a pulp, like the pulp from which paper is made. The pulp can then be compressed into any form or density which may be desired; and by regulating the surfaces in relation to the mass, the action can be controlled with the greatest nicety. Indeed, the excessive susceptibility of the substance, rather than its want of sensibility to control, is one of the chief difficulties which those who would wish to apply it have to contend with. But where the action does not require to be brought within such nice limits, as in mining operations, for example, gun-cotton has lately furnished some remarkably satisfactory results. Its application to sporting guns is a more difficult problem; but already Messrs. Prentice have achieved considerable success in this direction, and their pulped gun-cotton cartridges are said to have given very general satisfaction last season. This success is likely to be increased by the plan lately adopted by Messrs. Prentice of inclosing each charge in a thin skin of india rubber, quite impermeable to damp.

The application of gun-cotton to rifles is a step further, and is attended with greater difficulties. Although Messrs. Prentice exhibit some gun-cotton ammunition for the Snider and other rifles, it cannot be regarded as having any established value, and this part of the subject is as yet far from being satisfactorily worked out. But from what has been done in the lower applications of gun-cotton, and from the immense scope afforded by the pulping system in the matter of its control and arrangement, and

from the care and scientific knowledge with which the subject is now being worked out in England by a special Government Committee, we have every reason to look forward hopefully to the successful and much more general introduction of gun-cotton as a substitute for powder for all arms ; and it appears to us that Messrs. Prentice's contribution to the Paris Exhibition has a very high value and interest, as marking the progress which has been made in an almost new industry, and as shadowing forth the prospects or possibilities of its future.

The finest displays of small-arms in the Exhibition, and the most important, are those of France and Belgium. It is difficult to say which of these collections is the largest and most interesting.

French display of fire-arms. Noticeable features which distinguish French from Belgian arms.

In the French Court the display of sporting arms is larger than that in the Belgian Court, where the staple of the collection is military arms. We find, also, in the French Court greater novelties and more noticeable improvements than in the Belgian Court, resulting, doubtless, from the fact that France is mainly a producer of arms, Liège a reproducer. The French arms are generally conceived by Frenchmen ; as Lefaucheux, for example, was the pioneer of the modern breech-loading system in Europe. The Belgian arms are mostly, if not entirely, Belgian reproductions of foreign systems. If we wish to observe the bent and direction which improvements in small-arms are taking "the fashion of to-morrow," as the French would say, we should turn to the French arms ; if we wish, on the other hand, to examine the principal varieties of accepted or most approved systems, the Liège collection affords an opportunity of doing so. An example of this is furnished by the relative position of central-fire guns in the two countries. In France there is a general determination towards central-fire in preference to pin-fire guns for sporting guns ; it is fast coming into fashion and universal use, to the supersession of pin-fire guns. But in Belgium this advance has not yet been accepted. Central-fire sporting guns are exhibited by some of the Liège makers, but in very small numbers compared with the pin-fire or ordinary Lefaucheux guns.

There can be no doubt that pin-fire will ultimately be generally superseded by central-fire, and the next Exhibition will probably find the Liège Court filled with such arms. But the present Exhibition has occurred at that particular period of time which shows France on one side of the line and Belgium on the other ; and this example

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serves to illustrate a characteristic difference between the French and Belgian collections.

Another noticeable point of difference between the two is in the character of the arms manufactured. The French sporting arms are distinguished by a rare ornamentation. *Armes de luxe* form, as we have before observed, a specialité of the French gun trade, while in Belgium the arms are finished with that severe plainness which is characteristic of English guns. The Belgian sporting guns are for the most part as free from ornamentation as their military arms. In France, the value of a sporting gun is very much determined by the amount of labour lavished on the carved stock and engraved mountings and by its character as a work of art. Considered from this point of view, many of the French guns are exquisite; and the majority of the French gunmakers' cases furnish examples of these *armes de luxe* which will well repay inspection.

A further point of difference between the French and Belgian arms is the price. We do not wish to place extravagantly high-priced *armes de luxe* of France in comparison with plain Belgian arms, for such a comparison would afford no indication of the normal cost of a gun in the two countries. But, taking the least ornamented of the French guns, we find the prices for a double-barrelled central-fire gun ranging generally from 28*l.* to 32*l.*, while in Belgium the cost of such guns rarely exceeds 14*l.*

A final distinctive feature of the Belgian display as compared with the French is the vast number of *armes de commerce*, as they are called, which find a place in the Liège collection, but which seem to be almost unknown in France. These arms are prodigies of cheapness. A single-barrelled percussion-lock gun can be purchased for 6½ f.; a double-barrelled gun for 15f.; a pistol for 2½f.; a double-barrelled Lefaucheux gun can be bought for 48f.; and other arms of the same character are obtainable at correspondingly low prices. These arms are curiosities, as showing for how little a gun, not only complete in all its parts, but with a barrel which will withstand the Government proof and which in every case bears the guarantee mark, can be manufactured.

The guns are exported in large numbers to Africa, South Amercai, Cuba, &c., and are used as articles of barter in the slave and other trades.

Principal French exhibitors of fire-arms,

With this general sketch of the characteristic features of the French and Belgian collections, we may proceed to a

more detailed examination of the exhibits of the two countries.

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ammunition, and kindred appliances.

M. Houllier-Blanchard, of Paris, particularly claims for his guns excellence of workmanship, independently of high finish or ornamentation ; and, as far as we were able to judge, M. Blanchard's claim is not unfounded. His guns appeared to us of fine quality, and are certainly not surpassed by any exhibited by other French makers. The price of M. Blanchard's best central-fire double guns is not high (judged by an English standard), 700f., or 28*l*. M. Blanchard, in common with other French makers, lays great stress upon his "système de démontage," or facility for taking the gun to pieces. We are at a loss to understand why so much stress is laid upon this point by the French, and, indeed, by most of the foreign makers. In exhibiting a gun it looks pretty enough to see the barrels fall from the stock on the touch of a spring or bolt ; but no special advantages that we are aware of result from such an arrangement, and one gun is practically no better than another because it can be taken to pieces in two or three seconds less time ; and yet nearly every French gunmaker has been at the pains to elaborate some ingenious contrivance specially with this view.

In addition to his sporting guns, M. Blanchard shows a very handsome pair of gold inlaid pistols, which, with the fittings of the case, in gold also, are priced at 400*l*.

Spiral spring in central-fire guns done away with by several French makers.

The guns of Gastinne Renette have obtained a high character in France. He exhibits both pin and central-fire guns, with a preference for the latter. A novelty in M. Renette's central-fire guns consists in the method of withdrawing the piston or striker, which is done by attaching it by a simple piece of concealed mechanism to the hammer. The spiral spring is thus got rid of. M. Renette informed us that Mr. Lancaster has purchased the right to use this system in England, and that Mr. Purdey uses it. The arrangement adopted in the guns which Mr. Lancaster exhibits is, however, not the same in detail as M. Renette's, although resembling it in principle. Some military arms exhibited by M. Renette have no special value. They are not quick guns, and they require a separate motion for extracting, by means of a false ramrod, which serves to push out the cartridge, and acts much in the same way as the loading-rod in Colt's revolvers.

Some sporting guns which M. Renette has made for the Emperor and the Prince Imperial are worthy of notice. Although mounted in carved oxydised iron and silver, the

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ornamentation of these guns is not overdone, and, if one may judge from the cases of MM. Blanchard and Renette, the two first gunmakers probably in Paris, it would seem that some reaction against excessive ornamentation is setting in in France.

M. Renette has adopted Mr. Westley Richards's plan of breech-loading for sporting guns, and informed us that he had sold large numbers of guns on this system. He has also a system (snap action), which operates by a lever under the fore part of the trigger guard.

Among other arms of different sorts, M. Renette shows same breech-loading pistols adapted for copper rim-fire cartridges.

Prototypes of the Snider system.

M. Thomas has dispensed with a piston spring, but he does not, like M. Renette, attach the piston to the hammer. He incloses his piston altogether in such a way that it is not visible or assailable by damp from above, and it is left perfectly loose, to fall forward or back at will, or to be pressed back by the closing of the barrels. M. Thomas shows a military breech-loader with a loose piston of this sort. He has also a sporting breech-loader on a system resembling the Snider in its main feature, viz., a block which hinges upon one side; the block, however, closes two barrels instead of one. This system, he assures us, he applied to double-barrelled guns in 1854, and that he exhibited a gun on this system in the 1862 (London) Exhibition. The inventor of this system is said to be a Lieutenant Bonin.

Some military arms of Lieutenant Bonin's are shown in another case. One, which we were informed he made in 1854, closely resembles the Snider in its main features, except that there is no "shoe," the breech-block, which is hollowed out on the underside in the centre, being attached to the barrel itself. M. Bonin exhibits also an ingenious modification of the Snider arrangement which he has recently adopted, by which the striking arrangement is all inclosed in the block; and there is a third "système Bonin" on an altogether different principle, not unlike the well-know Sharp's carbine, except that the block is opened by the action of cocking the hammer and closed by the action of lowering the hammer. How far the modifications of the Snider construction are improvements it is difficult to say in the absence of a careful trial. The Snider system is favourably regarded by the French Government, who have adopted it for their conversions. The cartridge also is the Boxer cartridge, and we were so

fortunate as to have the opportunity of visiting the establishment of M. Gevalot, by whom these cartridges are being made, where we learnt that the resources of the establishment—the most considerable private cartridge factory in France—will be severely taxed to supply all the cartridges which the Government have ordered for the present year. The cartridge is said to have given great satisfaction.

Contrivance for using a breech-loader as a muzzle-loader on an emergency.

M. Thomas has adopted a brass chamber and nipple for loading breech-loaders with loose powder when desired. A similar arrangement for securing this object is now very generally employed in France; and it is reasonable to suppose that, shortly, no sportman's gun-case will be deficient of a pair of false chambers.

A novelty exhibited by M. Thomas is a gun for pin or central-fire cartridges, or which by means of a false chamber can be loaded with loose powder.

There are two practical objections to this ingenious arrangement, viz., that the rims of central-fire cartridges are almost invariably made larger than those of pin-fire cartridges (on account of the hold required for the extractor), and that thus a gun adapted for the one cartridge would be unsuitable for the other; secondly, that when central-fire cartridges are used there would be no support to the cartridge opposite the pin-hole, and an inconvenient escape of gas, and possibly worse accidents, might proceed from this cause.

Breech-loading revolving pistols.

M. Perrin exhibits several revolving pistols adapted for central-fire cartridges, and we may take this opportunity of again noticing that on the Continent self-igniting pistol cartridges have become almost universal, and capping revolvers are fast disappearing. We have already remarked on the backwardness of Mr. Colt in this respect. In all M. Perrin's central fire revolvers the striker forms part of the hammer.

M. Perrin claims for his sporting breech-loading guns that he uses less metal in the forepart of the stock than any other maker. The locking down of the barrels is effected by a novel and ingenious arrangement under the breech, the object of which is to increase the hold or tighten the locking in inverse proportion to the pressure of the gas.

Some of M. Perrin's *armes de luxe* are exquisitely beautiful.

M. Lefaucheux, the originator of the pin-fire system, is the only French maker who adheres entirely to this system, to the exclusion of central-fire. M. Lefaucheux has made

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no changes whatever in the system with which his name is now generally associated. His case, which is very large, contains guns ranging in price and quality from 12*l.* up to 80*l.* The revolvers exhibited by M. Lefaucheux are adapted, like his gun, exclusively for pin-fire cartridges. The principle of arranging the hammer for trigger-cocking as well as thumb-cocking has been adopted by M. Lefaucheux in common with the majority of the French makers. M. Lefaucheux shows a revolving rifle, with twenty chambers and two barrels, one above the other. They correspond in position to the two circles of chambers which are disposed in the revolving breech, and for which two hammers are provided. M. Lefaucheux shows a sword-revolver such as we have noticed before, and a military pin-fire rifle of no particular interest beyond the fact of its being perhaps a solitary example of a pin-fire military arm.

A skeleton steel stock for fitting to a revolver pistol is worthy of notice.

M. Devisme has several forged steel barrels to which he drew our particular attention, but on the quality of which it is of course impossible for us to pronounce an opinion. He exhibits a military breech-loading rifle adapted for metallic central-fire cartridges, but otherwise resembling the Chassepot and needle gun. It can be loaded in only two motions, and is capable, according to M. Devisme, of firing twenty shots per minute.

The arm permits of being readily disabled by removing the breech piston.

M. Devisme exhibits several explosive elongated bullets for use with smooth-bore guns, the weight being so disposed that the bullet will not turn over within ranges of 400 metres (1,312 English feet.) There is, however, no novelty in this proposition. He has also an explosive harpoon bullet, for whales, the explosion of a detonating composition within the bullet causing the release of two harpoons or barbed points which project on release, like the ribs of a half opened umbrella. Some poisoned explosive bullets for whales are also exhibited. In one of his guns M. Devisme has an arrangement by which, with pin-fire cartridges, the extractor is both on the pin and on the rim, a more just extractor being thus secured.

M. Devisme is, however, impressed with the superiority of central to pin fire, and his attention has latterly been mainly applied to the production of central-fire guns, of which he has some good examples. His guns range in price between 14*l.* and 28*l.*

Some revolvers, designated expressively *coups de poing*, are exhibited by M. Devisme, in which the barrel is altogether done away with, the chambers being made slightly longer than usual and sufficiently so to give all the accuracy requisite for the very short ranges at which revolvers would generally be used.

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Revolvers: "coups de poing."

M. Jarre shows a description of repeating-pistol which is novel, although we believe Mr. Gale of Plymouth has applied the same principle experimentally to rifles. The arrangement consists in a flat rectangular bar containing a number of chambers, each chamber being adapted for a pin-fire metallic cartridge. The bar replaces the revolving piece of an ordinary revolver, but, instead of revolving, it travels transversely across the breech of the arm, being fed by the action of the lock. When one bar is expended it is withdrawn and either replenished or another charge bar substituted. M. Jarre states that, with five bars of ten chambers each, fifty shots can be fired in a minute; and whether this estimate be quite correct or not, it is certain that the system permits of a very high rate of fire being attained.

The Jarre repeating pistol.

M. Choisie exhibits a plan for converting muzzle-loading sporting guns, at a cost of only 15f., into breech-loaders. He cuts off the breech end of the barrels and makes it moveable on a hinge. When the catch which he applies is released, a spring throws up the moveable breech into which the cartridges are inserted. The same system is applicable to the conversion of military arms.

MM. Le Baron and Delmas exhibit a novelty which we have already referred to in general terms—viz., a gun which is fired by electric agency. The apparatus is contained in the stock, which is thereby weakened to a considerable extent; but this defect might no doubt be overcome by the employment of a more simple apparatus. The advantages which are claimed for the employment of electricity as the agent of ignition of small-arms are—that the cartridges contain no fulminate and are therefore less dangerous in manufacture and in transport; that, being hermetically sealed at their base, no escape of gas can take place; that the arm cannot be fired accidentally; that it requires no blow to fire it, and that it is thus less liable to movement (*deviation*) at the moment of explosion; and that the rapidity of fire is also greater.

Gun fired by electric agency.

These advantages, however, are rather imaginary than real. We do not dispute that they belong to the system; but, on the other hand, the corresponding disadvantages do

Consideration of advantages claimed for firing guns

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by electricity.

not belong to an efficient system of breech-loading. Good breech-loading cartridges are not only not liable to accidental ignition, but in the event of one cartridge becoming fired the explosion is not communicated to the others. The manufacture of breech-loading cartridges is not attended with any special danger if conducted under ordinary precautions, and the fact that in the manufacture in the Royal Laboratory, Woolwich, of many millions of caps annually, only one accident (and that of a very slight character) has taken place within a period of eight or ten years, proves that practically the preparation of these articles is attended with little danger. Good breech-loading cartridges are not liable to any escape of gas; nor, as it seems to us, is the arm necessarily more liable to accidental explosion than the electric arm. The advantage of rapidity of fire can hardly be urged against a breech-loader adapted for a cartridge containing its own ignition, since the motions of loading such an arm and the electric gun would be precisely the same, if, as in many breech-loaders, the arm is made self-cocking; and the objection to percussion-guns on the score of their jerking at the moment of firing has no practical value, as is proved by the extraordinary results obtained at our rifle competitions. However, the exhibition of this arm, though crude and imperfect of its sort, has a certain interest, and the idea may be found capable of more scientific and useful development.

M. Geerinck, who has obtained several medals in preceding Exhibitions, has no novelty in his case, but takes his stand solely upon the excellence of his workmanship—a point upon which it is very difficult for us to pass any opinion.

The Bernard gun barrels.

M. Leopold Bernard's gun barrels have obtained a high reputation not only in Paris but throughout the Continent. They are all damascened barrels of steel and iron worked up together. The first process consists in twisting up together thin strips of steel and iron, and working them together under hammers. The bars thus produced are hammered out into strips, which in their turn are forged with other strips into thick bars, to be again elongated and again forged. These bars are ultimately coiled up into a barrel, planed, bored, and, if for double barrels, soldered together. Specimens of the barrels in the various processes are exhibited by M. Bernard and form an interesting display.

A central-fire gun exhibited by M. Lagrèze does not possess that novelty which the inventor claims for it. The point is

considered to be the direct action of the hammer in the axis of the gun; but arrangements for securing this have been effected in many breech-loaders; and M. Lagrèze's arrangement, although presenting some novel features, does not that we are aware, possess any special advantage. Some scissors which M. Lagrèze exhibits, and which are intended for trimming the ends of cartridge cases, would probably be useful to sportsmen who fill their own cartridges.

MM. Le Page-Moutier et Faure have a revolver cartridge which is novel and ingenious, but expensive in its arrangement. The object is to permit of the cartridge being easily and often re-charged. A more useful novelty in this case is a central-fire gun in which the piston is perfectly loose, and which when the gun is loaded projects and when the gun is not loaded falls forward. By coating the upper end of the piston with copper, or so colouring it that it would attract the eye, it would always be easy to observe whether the gun is loaded or not; the position or projection of the piston forming an unfailing indication. In this way one of the objections urged by the supporters of pin-fire against central-fire may be overcome.

Gun adapted for two charges in one barrel.

MM. Le Page-Moutier et Faure exhibit a muzzle-loading cap gun on the Belgian plan of having two bullets for each barrel. To those who have not seen guns on this system this weapon—of which other examples will be found in the Belgian Court—will prove a curiosity. The gun has two barrels, but four hammers. Each barrel is loaded with two charges and two balls; the front charges are fired by the front set of hammers, when the hinder balls form at the moment of explosion the breech of the gun. It is difficult to believe that the flash can be always prevented from passing to the hinder charge in this way; but the assurances which we received on this point leave us no grounds for doubt. When the front charges have been fired the hinder pair of hammers are brought into play to fire the hinder charges.

Whatever interest this gun may possess as a curiosity, such practical value as may have been at one time supposed to belong to it has entirely vanished with the general introduction of breech-loaders. The exact converse of this gun is to be seen in the Italian Court, where many guns are exhibited with four barrels and two hammers.

An exquisitely finished working model of a Chassepot rifle, one fourth the full size, is worthy of inspection as a sample of delicate workmanship. An *arme de luxe* exhibited by this firm is of fine taste and finish.

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M. Portalier has an arrangement by which the lock of his guns can be readily removed for cleaning or to disable the gun, simply by turning a little catch below the trigger guard.

Système glissière.

He exhibits a breech-loader on the *système glissière*—that is to say, in which the barrels slide forward upon the forepart of the stock. This system is not novel, though M. Portalier has so arranged it as to reduce the amount of friction surfaces (the necessary existence of which forms a salient objection to the system) to a minimum.

It is not likely that guns constructed on the sliding plan will ever find much favour. They are to be found occasionally in the hands of sportsmen, and some sale has been found for them in Belgium. In England the system is less known and is little approved. Our own experience of it has been decidedly unfavourable.

M. Tronchon shows his system of conversion, not unlike the Snider, except that the breech-block opens to the left. M. Tronchon has a few military arms, and among them a magazine gun for 12 charges.

M. Leroux also exhibits a magazine gun of no special value, and for which, indeed, he claims no higher rate of fire than 15 shots per minute, a rate which is easily surpassed by most breech-loaders of any pretensions. The system, in respect of having a magazine under the barrel, is not unlike that of the well-known Henry repeater, but it is more complicated. M. Leroux has a capping gun which is curious, but of no useful importance. The gun caps itself, 25 caps being arranged in a little magazine under the barrel and falling by their own weight. As each cap arrives opposite the nipple it is adjusted thereon by the mechanism which is called into play by the action of cocking.

M. Leroux has an elongated bullet for firing out of a smooth-bore gun, rotation being effected by the action of the gas upon the wings of the ball. Projectiles on this principle are no novelty, but their employment has never yet been attended with any substantial success.

M. Leroux has contrived a little "powder conductor" for depositing the powder at the bottom of the barrel of a muzzle-loading gun without any coming into contact with the sides. Such slight value as this contrivance may have possessed for match shooting, disappears on the general introduction of breech-loaders.

MM. Cohen, Lyon, and Co. exhibit a Chassepot rifle, the adopted arm of the French infantry, and a system of con-

version designed by M. Chassepot which has not been adopted.

The following particulars respecting the Chassepot rifle are given by MM. Cohen and Co., and may be interesting :—

The Chassepot rifle.

| | French Measurement. | English Measurement. |
|---|---|---|
| Weight | 4 kilos, 50 grammes | 8 lbs. 14 ozs. 13 drs. |
| Calibre | 11 M. metres | ·433 ins. |
| Range | 1,000 metres | 1,094 yds. |
| Weight of cartridge | 31 grammes | 578·4 grs. |
| Weight of ball | 24 grammes | 370·4 grs. |
| Weight of charge | 5½ grammes | 84·8 grs. |
| Initial velocity | 450 metres | 1,476·4 ft. |

Number of grooves, four.

M. Martin shows a description of oil for preventing rust on iron or steel work, price 4f. a box. Some of the oil had been applied to some steel cannon exhibited by Petin, Gaudet, and Co., apparently with good effect.

Belgian fire-arms.

We have noticed in general terms the character of the Belgian display of arms, and wherein it differs mainly from the French collection. The largest exhibitors are MM. Lemille, Malherbe, and Co., Dresse-Ancion, Laloux and Co., Lanbin, and Lepage.

Principal Belgian exhibitors.

M. Lemille's display of military breech-loaders is worthy of inspection. It contains samples of all the arms which this establishment has manufactured for foreign Governments and for private inventors. Among these systems are many which are quite unknown in England—mere projects of no practical value whatever ; but, as displaying the activity which prevails in this department of gun making, and the infinite variety of plans which have been tried or are being tried, this collection has a high value. Among the arms are those of Laron, Gevelot, Lemille, Benjamin, Storm, Albini, and Braendlin (which system has been adopted by the Belgian Government for their military conversions), Ghazé, Dépret, Westley Richards, Remington, Bernard, Chassepot, and some others.

Malherbe and Co., one of the most important houses in Liège, exhibit, among other military breech-loaders, the Karl, said to have been adopted in Russia, Peabody, Remington, some Norwegian and Swedish chamber-loaders, Reider (a sort of modification of the Amssler-Milbank), and Hubert system. M. Hubert is the Directeur at Liège, and claims to have designed a system resembling the Peabody

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in its general features before Peabody's arm was brought forward.

We have already referred to a characteristic feature of the Belgian arms—viz., their exceedingly low price.

Cheapness of the Belgian arms.

Some of the cheapest arms will be found in the collections of M. Dresse-Ancion, Laloux and Co., M. Lambin, and MM. Lepage and Chauvot. The *armes de commerce* of these makers are all of about the prices already quoted by us—viz., single-barrelled guns from 6½f. to 7f.; double guns, 15f. to 16f.; pistols, from 2f. to 3f.; and double Lefaucheux guns, about 50f. The prices mount up gradually, according to the workmanship and character of the gun, until they attain a maximum of about 250f. to 300f. for the best breech-loading sporting gun (pin or central fire), with barrels by Leopold Bernard, of Paris.

Small breech-loading saloon rifles, on a system not unlike that adopted in the well-known Remington revolver, can be purchased in the Belgian Court for 21½f. to 26f., according to the calibre; six-shot revolving rifles for 55f.; ten-shot revolving rifles, 70f.; all adapted for pin-fire cartridges. Breech-loading saloon pistols can be purchased for 8½f.; and revolving pistols (French service pattern) for 21½f. These quotations will sufficiently indicate the extremely low price of the Belgian arms. In this court are to be seen the swords with revolvers in the hilt, of which we noticed samples in the French Court; these weapons can be purchased from the Liège makers for 50f. complete, or of a larger size for 72f. We were informed that they were much used by the Italian officers. The same principle is applied to couteaux de chasse, which are fitted with small revolvers, and cost from 45f. to 50f., according to their size. Some pistols (Sharpe's patent, 1859) are exhibited with four barrels and one hammer; the point of the hammer revolves instead of the barrels firing the charges in succession. These pistols are adapted for central fire cartridges.

The *Société Anonyme*, of Liège, exhibit several breech-loading arms; and M. Galand has some military breech-loaders on a system of his own, which he professes to be able to supply at 27f. M. Galand has some very cheap sporting guns, breech-loaders, at 27f.

Prussian fire-arms.

The collection of arms contributed by Prussia is small; but it seems to us important, as including a description of arm not to be found (that we could discover) in any other country. This arm, the invention of Prince Pless, is largely used in Prussia for sporting purposes. It is adapted for

Système Pless.

central-fire cartridges, but the hammer and lock of ordinary central-fire guns are done away with, and a pair of horizontal strikers, worked either by a spiral spring, or by a lock, similar in the general features of its construction to the ordinary lock, but without hammers, are substituted. The striking arrangement is in guns of the first sort similar in some respects to that of the needle gun, with the important difference that the striker is blunt and not sharp, and that the gun is adapted for the ordinary central-fire cartridge, instead of the consuming needle-fire cartridge.

The gun "breaks down" at the breech for loading, much as an ordinary breech-loading sporting gun; but the action of opening is effected by a lever underneath the fore part of the trigger guard, which works forward in a vertical plane; and, in opening, the gun forces back the strikers into the position of full cock. There is a simple arrangement by which the gun can be placed in a condition corresponding to that of half cock with a hammer gun. It is unnecessary that we should attempt to describe more exactly the mechanism of the gun; but the system appears to us to possess considerable merit, and we were informed that it was severely tested by the jury of this class by actual firing and gave satisfactory results. Some well finished guns on this system are shown by Barella, of Berlin. Their price varies according to the amount of ornamentation; but a thoroughly good gun on this system, finished plain (in the English style), and as well made in all respects as the more expensive guns, can be purchased for about 15*l.*

We attach some importance to this system, because we believe it to be a step in advance of the hammer and lock guns. Now that central-fire is generally coming in, the retention of the hammer, which was designed for a different system of ignition, is quite unnecessary. "When "it is borne in mind that this description of lock was first "introduced with the old flint and steel guns, and that "the copper cap was invented partly with a view to its "applicability to this lock, there seems no reason for "slavishly adhering to it when the other parts about the "breech of a gun have been so thoroughly revolutionized."*

The abolition of locks and hammers will no doubt encounter great opposition, and chiefly on the ground that spiral springs are objectionable. We believe, however, that the objections to spiral springs rest upon no sufficiently

* Captain Haig, R.A., on "Military Breech-loading Rifles and their Ammunition."—*Proceedings Royal Artillery Association*, vol. v., p. 248.

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solid basis, and that mechanically they are at least as reliable as the flat spring at present employed in gun locks, and that any undue susceptibility to injury by the action of damp, or under such a condition of atmosphere as is met with at sea, may be readily neutralized by japanning or otherwise protecting the spring from these influences. However, as we have pointed out, the spiral spring is not a material element in the Pless system. The guns are made without any spiral spring whatever, and to these guns we should be inclined to give the preference, the more so as some experiments which we have had an opportunity of making with one of them have furnished highly satisfactory results, and the breech action has proved safe, quick, and simple. We believe that these guns were also tested by the jury, with satisfactory results.

MM. Leue and Timpe, of Berlin, also exhibit sporting guns on the *système Pless.*

In addition to the sporting guns on this system, M. Barella and MM. Leue and Timpe exhibit double-barrelled sporting needle guns. The system of opening and cocking is the same as that in the guns which we have described; but self-consuming cartridges, instead of central-fire cartridges, are employed. This constitutes a most important difference. In the central-fire Pless guns the gas check is furnished by the cartridge case; in the needle-fire Pless guns this function has to be performed by the gun; and, in our opinion, such an arrangement is false in principle, although the objections to it will, doubtless, not be so obvious in smooth-bore sporting guns as in military rifles, in which the strain and local action are much more intense. In some remarks which we shall make on the subject of cartridges we shall have occasion again to refer to and more fully to explain this subject, merely indicating in this place the grounds on which we regard the needle-fire Pless gun as vastly inferior to the central-fire guns on the same system, although the difference between them may primâ facie appear but slight.

Messrs. Kœnig and Reeinart exhibit some gun barrels, chiefly of cast steel.

M. Berger, M. Otto, and M. Schilling, have nothing noticeable in their cases; indeed the whole interest of the Prussian exhibition centres in the Pless guns, exhibited by M. Barella and MM. Leue and Timpe. It should be noticed that all the German sporting guns are fitted for slings: the barrels, unless otherwise demanded, are elaborately traced by the action of acid, and the stocks are fitted with a bulge

or cheek piece on the inner side. These embellishments are, of course, dispensed with, if required.

Bavarian arms.

The small arms exhibited by Bavaria are of no special interest. Baader and Son show a lion-hunting gun, which they designate "System of Gerard and Lancaster," and a central-fire rifle gun.

Stiegele shows some highly ornamented Lefaucheux guns.

Austrian fire-arms.

The Austrian collection of arms is not inconsiderable, but its value is enormously diminished by the fact that the majority of the guns are sealed up in a way which renders it impossible to inspect them. No very reliable estimate of the merits of a breech-loading system can be formed, it is true, from a simple inspection of the breech-action and without actual experiments; but when the breech-action is secured with wire and a lead seal, the exhibitors having left strict instructions that their representatives should not disturb the seals, the gun can hardly be said to be exhibited at all. There were several breech-loaders which we would have gladly inspected, but this restriction rendered it impossible for us to do so; for example, the Wänzle system, which the Austrians have adopted for their conversions, and which is exhibited by Würzer, is naturally an object of interest, but an inspection of it is rendered impossible by the sealed wire over the breech.

This extraordinary practice of sealing up the guns is applied in some instances to well-known systems of breech-loading. Habermann, for example, has sealed up his specimens of the needle-gun, the Remington, Amster, Milbank, &c.

A distinctive feature of the Austrian arms is the multi-barrelled pistol, to which the name of "revolver" is incorrectly applied. These pistols have four, five, or six barrels, which do not revolve, but open, on the Lefaucheux system, or an occasional modification of that system, and are adapted for rim-fire cartridges. Some revolvers are also exhibited. In every instance the multi-barrelled and revolving pistols are adapted for cartridges containing their own ignition: the percussion-cap has completely disappeared for these arms.

Examples of these multi-barrelled pistols are exhibited by Beidermann, Grünbaum, &c. Peterlongo exhibits a case of duelling pistols; for these the percussion-cap is retained—but whether because the demand for duelling pistols on the new system is not large enough to create a supply, or whether because of any fancied superiority in the old

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system for this particular purpose, we are unable to state.

A good many rifles are exhibited by Maurer, Würzinger, Peterlongo, and Schaschl. Nearly all the Austrian rifles have a third sight situated behind the hammer, immediately in front of the eye, as in the English long range match rifles.

Austria occupies, on the whole, a sort of middle position with regard to price, workmanship (as far as we could judge), and novelty. She is cheaper than France, and perhaps a little dearer than Belgium. The workmanship appeared to vary greatly, and the best guns are fitted with French (Leopold Bernard's) barrels. One or two of the breech-loading systems are new, but the majority are copies of foreign arms.

It is to be regretted that more has not been made of the Austrian collection, and that greater facilities are not afforded for the inspection of the arms and for obtaining information respecting them.

American fire-arms.

The American display of arms is interesting, because undoubtedly breech-loading, especially in its relation to the military service, has been more studied and has attained a higher development than in Europe. Speaking broadly, we may say that the best military breech-loaders have been obtained from America, which country is also the parent of the repeating and magazine rifles, at least in modern days, for samples of magazine rifles made in 1650 are exhibited among the Danish contributions to the "Historie du Travail."

Most of the best-known American breech-loading rifles are exhibited, as the Spencer, the Remington, the Ball, the Palmer, the Peabody, and the Lanson (system of conversion).

Messrs. Smith and Wesson exhibit revolving pistols and cane rifles, adapted for pistol cartridges. They are the owners of an American patent (1855), which has seriously hampered the application of self-igniting cartridges to revolvers. By this patent Messrs. Smith and Wesson hold the right in America of boring the revolving chambers from end to end.

Although it may perhaps not be impossible to contrive a pistol adapted to self-igniting cartridges, the chambers of which are not bored from end to end, such an arrangement is necessarily a roundabout way of achieving what Messrs. Smith and Wesson, by virtue of their patent, accomplish much more simply. Thus makers of revolving pistols,

desirous to go with the age and to abolish caps, must either manufacture under a licence from Messrs. Smith and Wesson, or must contrive some system which will render them independent of this patent, and which will yet be as cheap and efficient. To this cause we believe is to be traced the backwardness of Messrs. Colt in this matter. They are unwilling, as we understand, to purchase a licence from Messrs. Smith and Wesson; and their efforts to accomplish the application of self-igniting cartridges to revolvers without infringement of the patent referred to, have not yet met with the success which they are sanguine will ultimately crown them. In countries where Messrs. Smith and Wesson's patent does not hold the system of capping revolvers, as we have noticed, has entirely disappeared.

One feature of American rifles, as opposed to our own, is the excessive smallness of the bore and lightness of the projectile and charge. This is carried to a conspicuous extent in the Henry repeating rifle, the object being, of course, to admit of a larger number of charges being contained in the magazine, and thus to enable a greater number of shots to be fired without replenishing the magazine, the operation of replenishment entailing each time a distinct interval of inefficiency, and forming an objection to the repeating arms.

This objection is overcome or obviated in the magazine rifles of Ball and Lamson, and in the later patterns of Spencer's rifle, by an arrangement which permits of the arm being loaded as an ordinary breech-loader, the magazine being held in reserve for a critical moment, and when exhausted, the simple breech-loading action can be fallen back upon.

This improvement is so great that it will doubtless be universally applied to repeating arms. We may mention that in America repeaters have quite superseded the revolving rifle, which was merely a cumbrous and objectionable form of repeater.

Holland shows a small and unimportant collection of fire-arms, sporting and military, made at Maestricht and Rotterdam. Dutch fire-arms.

The case of arms in the Russian Court includes military cap-guns (one a breech-loader) and some sporting guns, one of which is adapted for central-fire cartridges. Russian fire-arms.

Spain exhibits a case of arms of no special interest beyond the fact that the collection includes two military breech-loaders—a Snider and a Peabody. Spanish fire-arms.

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The Swiss arms, like those of Austria, are carefully secured by wires and seals, so as to render an inspection impossible. They are chiefly cap-guns.

Swiss fire-arms.

Norwegian fire-arms.

Norway has had a breech-loading arm in use for military purposes since 1846. The pattern underwent slight alterations in the calibre in 1849 and 1860. This was the Hägstrom, a capping arm on a chamber-loading system. It is a type of the lowest order or group of breech-loaders. A chamber-loader of this construction is, in fact, merely a muzzle-loader cut short, or so arranged that the arm can be conveniently loaded by hand without the assistance of a ramrod. The charge is deposited in a short chamber instead of being rammed all the way down a long barrel, and the chamber is then replaced in the position for firing in the prolongation of the barrel.

Perhaps for loading with loose powder, or wherever the cartridge is not designed to take the escape of gas, chamber-loading is the safest system of breech-loading; but it is open to several objections, among which the firing through a joint, and the fact of the strain being necessarily thrown more largely and directly upon the breech action, are conspicuous. On the introduction of cartridges containing their own ignition and furnishing their own gas check, the advantages of chamber-loaders vanish, while the objections remain; and Norway is very wisely converting her chamber-loaders into breech-loaders proper, by an ingenious and inexpensive modification of the Peabody system. The conversion of these arms is said to cost only 6f. The conversion, which gives promise of being simple and successful, would have been better had central-fire been substituted for the rim-fire generally employed in the Peabody arms; these arms are well worthy of inspection.

Swedish fire-arms.

Sweden exhibits some projects for central-fire breech-loaders which have not yet been adopted.

Fire-arms in "Histoire du Travail."

That circle of the Exhibition which contains the "Histoire du Travail" is well worth visiting by anyone interested in small arms, as many prototypes of the various perfected modern systems are to be found here. We have already mentioned the two Danish magazine arms of 1650. The same nation exhibits a revolving (flint lock) rifle of 1597; and although cannon do not enter within the scope of this report, we cannot refrain from noticing a breech-loading cannon fitted with a movable vent piece, clamped with a screw, on a system which embodies the leading features of the Armstrong method of breech-loading, which was made at Copenhagen in 1761.

Some of the specimens of breech-loading matchlocks of the middle of the seventeenth century are extremely interesting. Other breech-loading arms of this period are provided with a wheel flint lock.

The Russian collection, from the Palais des Armes at Moscow, contains rifled small arms of 1626, 1668, and 1693, a six-chambered revolver of 1670, and some revolving double-barrelled guns of the seventeenth century (precise date not specified).

A curiosity in the English collection is a shield from the centre of which projects (like a gun from the turret of a modern ship-of-war) the muzzle of a breech-loading pistol; these shields formed part of the equipment of the body guard of Henry VIII., date 1530.

We regret extremely that on the occasions of our visits this gallery was far from complete. No doubt several valuable examples will now be found in those collections which were not in a sufficiently forward condition to admit of our inspecting them.

Military fire-arms.

Scattered about through the Exhibition and in the various Government collections are a few specimens of military arms in addition to those which we have already noticed; but for the most part these are muzzle-loading arms, and have little interest at the present time. Every nation is now engaged either in the conversion of its existing rifles or in the production of new systems. This activity in the introduction of breech-loaders for sporting and military purposes, and the almost universal supersession of muzzle-loaders, constitute, as we have before stated, the chief features and characteristic of this display of small arms, as compared with similar displays in preceding exhibitions. From this cause a greater importance attaches to cartridges than has ever belonged to them on former occasions. On this important subject we propose to make a few concluding remarks.

Increased importance of cartridges consequent on general introduction of breech-loaders.

Two systems of cartridges for breech-loaders.

In a breech-loading arm but one of two methods of securing the arm against a gas escape is possible; either the gas check is effected by the arm itself, or it is effected by the cartridge.

The needle-gun is an example of an arm of the first class, so is the Chassepot rifle, and so is the Sharp's carbine, with which the British cavalry in India are still armed. To us this system appears less sound in principle and very much less safe in practice than the opposite system of effecting the obturation by means of the cartridge. When the

Objections to self-con-

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suming cartridges.

escape is taken by the arm a necessity arises for a perfectly mechanically gas-tight joint. Such a condition necessarily seriously hampers the production of an arm, for such a joint is not easily combined with rapidity of action and simplicity and durability of construction. One or other of these three fundamental requirements of a good breech-loader is almost necessarily violated in the attempt to get a reliable joint. For example, in the Chassepot rifle, and in several other arms, the escape is effected by an expanding india-rubber ring, but the employment of india-rubber in any part of a military arm, and especially where it is required to fulfil an important function, is objectionable, and such a joint must be pronounced to be obviously wanting in durability. In the Sharp's carbine, where the joint is of a sufficiently durable and simple nature, it is not effective, and the arm is not gas-tight. A superior way of preventing the escape is by employing a closed chamber, as in the Mont Storm and other breech-loaders of this class. But chamber-loaders are open to other grave objections; and an arrangement which entails, as all chamber-loaders, we believe, do entail, the firing through a joint (the point of junction between chamber and barrel), appears to us to be false in principle and condemnatory of a system which requires it, independently of its other possible imperfections.

However, if we assume the existence of an absolutely tight and reliable joint the principle of throwing upon such a joint each time the gun is fired, to the extent probably of many thousands of rounds, a severe strain, seems less sound than that of renewing the joint, for such the cartridge case in the opposite system may be considered to be, each time of firing. Moreover, it should be remembered that while the slightest injury to the joint in the first case renders the arm unserviceable, such injury as the cartridge may receive, or any defects in its construction, will in the second case generally be sensible only for one round; and when that cartridge is replaced by a good one the gun becomes again perfectly serviceable and sound.

General disposition towards non-consuming cartrigdes for breech-loaders.

These considerations have operated in creating a very general disposition among gunmakers and others in favour of the second system—i.e., the effecting of the gas check by means of the cartridge. In France this feeling is very strong, and on these grounds the adoption of the Chassepot rifle is not generally approved by the French gun trade. Some indication of the same feeling among the French officials is afforded by the fact that the system of conversion

now being adopted for the French service is, as we have mentioned, substantially the Snider breech-action with the Boxer cartridge.

Another objection to effecting the obturation by means of the arm is that such an arrangement necessitates the employment of a so-called self-consuming cartridge. Such a cartridge is not only *not* self-consuming in every instance —that is to say, pieces of the paper are sometimes left behind and interfere with loading, and this constitutes a well-known and well-established defect of arms of this class; but being necessarily thin and slight they are less capable of resisting damp and rough usage than the stouter cartridges, which require to be withdrawn after firing. The "self-consuming" cartridges have, no doubt, the advantages of cheapness; but this cheapness being purchased at the expense generally of efficiency in arms and ammunition, is a false economy; and the superior rapidity of fire which they might be supposed to admit of has not as yet been established in practice.

Of cartridges of the second class, those which constitute, as it were, the breech or chamber of the gun at the moment of firing, there is a very large variety. The best-known cartridge of this class is the ordinary papier-mâché, Lefaucheux (pin-fire), with brass base.

Improvements have been effected in these cartridges in the past few years by which the blowing out of the pin, and the consequent escape of gas, is obviated. This is effected by an interior lining or disc of brass, which slightly increases the price of the cartridges.

M. Gevelot sells four qualities of pin-fire sporting cartridges. The price (No. 16 gauge), empty cases, ready for filling, is,—first quality, 45f. the 1000 (wholesale); second quality, 37f. ditto; third quality, 32f. ditto; fourth quality, 23f. ditto.

The difference in quality between No. 1 and No. 2 consists in the former having an internal lining of paper about the base, and in the pinhole being pierced in a way which throws up a burr and tends to prevent escape.

The third quality differs from the second in the description of paper employed, and in the strength of the base.

The fourth quality differs from the third in not having a small brass chamber to serve as a *point d'appui* for the cap, and in the general make and character of the cartridges.

Metallic coil cartridges.

In some instances a thin metallic coil, with paper inside and out, rolled up with the brass, or, in other instances

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Their advantages.

with paper inside only, is substituted for papier-mâché for the case. Cartridges made either in this way or of a plain thin coil of brass soldered at the edges are manufactured by Gevelot, Chaudin, Beringer-Rochatte, and other French makers. There is a favourable disposition towards these *carton métallique* or impermeable cartridges for sporting purposes even, and the impression that nothing but metallic cartridges are admissible for military use prevails very largely. The benefit to be derived from the employment of a metallic cartridge for sporting purposes, unless considered in connection with the number of times that the cartridge can be refilled, may not at first be apparent; but the advantages which recommend its use for military service, such as non-liability to expand or become injured by damp, greater durability, easier loading and extraction, do exist, nevertheless, in the metallic sporting cartridge, although they would not take so high a rank in the eyes of the sportsman as the soldier, because the disadvantages of papier-mâché cartridges are not so severely felt in a sporting as in a military cartridge, for which latter purpose, indeed, we hold papier-mâché to be absolutely inadmissible. The question of the employment of metallic cartridges for sporting purposes resolves itself, then, less into a question of efficiency than of price, though the former question will be present in some subordinate degree; and as regards price looking to the number of times that metal cartridges can be refilled—fifteen or twenty, or even oftener—looking, also, to the more everlasting quality of the metal cartridge, and to the fact that as the base and expensive parts of a cartridge, whether the cartridge be a paper or metal one, *must* be made of metal, the difference between the two consists merely in the substitution of metal for the case—a difference which, in reality, entails very much less extra expense than might at first sight be supposed; and, finally, looking to the fact that the metal, as old metal, always retains a considerable value, whereas the paper cases are practically useless—taking all these points into consideration, we believe that coiled brass cartridges will be found, in the long run, to be actually cheaper than paper, and but little more expensive even in their first cost.

A decided preference is expressed by the French and Belgian makers for coiled brass over solid copper or solid brass cartridges, though samples of each description are exhibited. The principal advantages claimed for coiled brass cartridges, such as have been adopted for the service

ammunition of this country, are their less cost and weight. The copper cases are nearly double the price of coiled cases in France; and in America, where the machinery for their production has been perfected, they are about one-third dearer than coiled brass would be. They are necessarily heavier than coiled brass. The question of their relative efficiency has scarcely been considered abroad to the same extent as in England, but it has been so far considered in France as to have induced the Government of that country to adopt a coiled brass cartridge for their converted military arm.

On the whole, central-fire, as we have already mentioned, is preferred to either pin or rim fire.

Preference for central-fire system of ignition.

The employment of either system is a question which affects the cartridge rather than the gun, and the advantages claimed for central-fire are—that it is more convenient than pin-fire, which necessitates the adjustment of the pin in a particular spot in the gun, and tells, therefore, to some extent against extreme rapidity; moreover, pin-fire entails a projecting pin upon the cartridge, which is inconvenient for transport.

Objections to pin-fire.

Objections to rim-fire.

The principal objection to rim-fire is the undue and excessive strain which it throws upon the weakest part of the cartridge (the rim) by the explosion within it of a quantity of fulminate, and also by depriving it of the protection of a paper wad, such as in most pin and central fire cartridges preserves this part of the cartridge from the action of the powder gas.

It is admitted that central-fire is dearer than rim-fire, but the saving of expense is considered to be more than counterbalanced by the increase in efficiency. In America rim-fire cartridges are more in favour than in France; but we learn that even in America it is being fast superseded by central-fire. One advantage claimed for rim-fire in addition to its cheapness is that if a misfire occurs at one part of the rim the cartridge may be turned round so as to present another part of the rim to the striker. The force of this plea appears to us to have been much over estimated. In the first place, the operation of turning round the cartridge would in most breech-loaders involve very nearly, if not quite, as much trouble as the substitution of a fresh cartridge; and if it be argued that a cartridge will thus be saved, we would answer that the per-centage of misfires in any cartridges constructed with ordinary care should deprive this plea of any practical value. In the second place, the chances of misfire with rim-fire cartridges are

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much greater than with central-fire cartridges, owing to the difficulty of ensuring a perfectly continuous ring of fulminate being placed round the rim.

Different varieties of central-fire cartridges exhibited by M. Gevelot.

The finest collection of cartridges of all sorts in the Exhibition is that made by M. Gevelot in the French Court. Among the cartridges, in addition to specimens of the various descriptions which we have mentioned, are several varieties of central-fire.

One sort has a pin in the centre, a central-pin-fire cartridge, so to express it. These cartridges cost about 10f. a thousand dearer than the ordinary pin-fire.

Another description has no pin nor cap or anvil, the fulminate being enclosed between two discs of metal, the base and an inner disc, the latter being pierced with a fire hole. This sort are very expensive, owing to the necessary thickness of the inner disc, and M. Gevelot considers them dangerous to manufacture.

In a third sort (equally costly) the inner disc is indented, and forms at once an anvil and a chamber. This is all inclosed by the base disc.

In a fourth sort the cap chamber itself forms the cap, the fulminate being situated at the bottom of the chamber; the anvil is driven forward on to the fulminate, and the ordinary action of driving the cap on to the anvil is thus reversed. The base disc incloses the whole. The cap chamber is fixed by an iron disc. These cartridges are cheaper than the ordinary central-fire, and only about 6f. dearer than pin-fire.

In another sort two caps are placed one within the other, having a highly delicate fulminate between.

There are of course also samples of the ordinary central fire, in which an anvil is fixed at the bottom of a chamber, and a percussion-cap is placed over the anvil. These cartridges are about 10f. dearer than pin-fire. These varieties are interesting as exhibiting the attention which central-fire is now receiving in France, and the amount of ingenuity which is being lavished in perfecting and cheapening it. Nearly all the novelties in cartridges and all that is interesting will be found in M. Gevelot's case, though the cases of MM. Chaudin, Gaupillat, Beringer-Rochatte, and Tardy Frères, in the French Court, all merit attention. M. Parent and M. Tronchon exhibit a few cartridges—the latter one of paper covered with india-rubber. M. Chaudin has substituted (for cheapness and for sportsmen) a papier-mâché disc for the ordinary metal base. It is very questionable how far this construction

would answer or admit of extraction (or insertion), should the cartridges become damp. M. Beringer-Rochatte has a rim-fire cartridge with the rim not in the edge but round the side, and this rim is struck by a pin in the gun. In Prussia, Dreyse and Collembursch show some cartridges, chiefly copper, and some samples of caps. In Belgium, the houses of Backmann, Dits, Fusnot, and Wassiege exhibit cartridges of different sorts, including some of the "cartons métalliques" noticed in the French collection.

The English display of cartridges possesses, as we have observed, but little interest, and we did not discover in any other of the collections but those named any exhibition of cartridges worthy of mention.

## Reports on Military Hospital and Barrack Buildings, Field Hospital Equipments, and Military Telegraphy and Signalling. — (Class 37.) — By Major Leahy, R.E.

### Military Hospital and Barrack Buildings.

Improvements effected since 1855.

During the twelve years which have elapsed since the last Paris Exhibition great attention has been directed to the construction, equipment, and administration of military hospitals and barracks; valuable statistics have been collected, important principles of construction have been enunciated and carried out, the system of hospital administration has been improved, and greater importance has been attached to sanitary science in all its branches. It is not proposed in the present report to do more than indicate, in a very general way, the improvements illustrated in this Exhibition of 1867, and for further particulars reference should be made to the published reports of the commissions which have inquired into the subject.

The following are some of the more interesting reports, &c. on barrack and hospital construction and administration:—

Report of the Commissioners appointed to inquire into the Sanitary Condition of the Army (London, 1858); General Report of Commission for improving the Sanitary Condition of Barracks and Hospitals (London, 1861); Etude sur les Hopitaux Consideré sans le Rapport de leur Construction, &c., par M. Armand Masson (Paris, 1862); Suggestions in regard of Sanitary Works required for improving Indian Stations (London, 1864); Report descriptive of the Herbert Hospital, by Captain Galton (late R.E.), F.R.S., Assistant Under Secretary of State for War (London, 1865); La Commission Sanitaire des Etats Unis, par T. W. Evans (Paris, 1867); Notes on Hospitals, by Miss Nightingale, third edition; Regulations for Medical Officers and Purveyors (British Army).

The English Government has, more than that of any other country, directed its attention to improvements in permanent military hospitals and barracks. In 1857 a Royal Commission, under the presidency of the late Lord Herbert, was appointed to inquire into the sanitary state of the army, and on the recommendation of this Commission a

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committee was nominated to follow up the inquiry, and make recommendations in detail as to the improvements to be effected in barrack and hospital construction. Acting on the recommendation of these bodies, and supported by the influence which attached to the opinions expressed by Lord Herbert and others, the successive Ministers of War have proposed and obtained the sanction of Parliament and of the nation to an expenditure on military dwellings far in excess of that which had been incurred prior to the Crimean War, and the result has been that in no country are the troops, especially the private soldiers, so well housed as in the new hospitals and barracks which have been constructed within the last ten years.

Hospital construction. Examples exhibited.

A building has been constructed at the expense of the British Government in the park of the Paris Exhibition which affords examples of some of the approved types of arrangement in permanent barracks; and, although the structure is of a temporary character, and has been roughly finished, it will give an idea of the principles adopted, and of the nature of the accommodation now provided for British soldiers.

In the collection of Dr. Evans, and in the American section of the main building, gallery No. 2, will be found models and plans of some of the general hospitals established by the United States Government for the reception of soldiers disabled during the civil war of 1861–4.

In the Austrian section, gallery No. 6 of the main building, will be found plans of a new barrack now being constructed at Vienna.

The French Government exhibit models of most of the barrack buildings erected at the camp at Chalons; but models of hospitals do not appear among the selection.

Sanitary effect of improved constructions.

The question of hospital construction and army sanitary administration has not, however, been neglected in France. The earlier examples of the type of building which is now most generally approved are to be found in the Lariboisière Hospital in Paris, and in the great military hospital at Vincennes.

The statistics of the French army in Algeria show that the improvements which have been introduced since 1848 in the sanitary and hospital arrangements of that army have reduced the mortality to one-third the proportion which formerly obtained.

In England the proportion of men constantiy sick is, at certain stations where improved constructions have been adopted, less than half the average number under treatment

before accommodation was provided on the scale now considered necessary.

In India the sanitary improvements which are now being carried out promise to produce a most important effect on the health of the troops employed in that country.

These and other advantages are due to the interest taken in sanitary matters, and they must be satisfactory, not only to the scientific men by whom the questions have been investigated, and who have proposed the improvements, but also to the statesmen and others who have urged the subject on the consideration of Governments.

It ought also to be satisfactory to the public bodies or nations by whom the necessary funds have been provided, to know that the expenditure incurred has produced good results.

Sanitary principles to be observed in military dwellings.

The leading sanitary principles to be observed in the construction of military hospitals and barracks have been laid down as follow :—

1. Avoid the collection under a single roof of too large a number of persons—especially of sick.

2. Give ample floor and cubic space.

3. Provide abundant ventilation direct from the outer air.

The position of a barrack must primarily be determined by military considerations, and that of the accessory regimental hospital is generally regulated by the site of the barracks.

The advantages to be sought for, and which should not, without sufficient reason, be dispensed with, are :—

1. Avoidance of marshes and stagnant water, which might give rise to malaria.

2. Abundant water-supply.

3. Sufficient elevation for drainage to an accessible outfall.

4. Porous subsoil.

5. Ample space, not only for the healthy disposal of buildings, but also for exercise and recreation.

The structural arrangement of military buildings should provide for the maintenance of discipline and for administration under military regulations ; but in the construction of hospitals the main object sought, viz., the recovery of the largest number of sick men to health in the shortest possible time, should never be lost sight of. Hence if, for very special reasons, a barrack be placed on a site which is not, or cannot be made, healthy, the possibility of placing the hospital elsewhere should be considered.

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The principles which govern the construction of permanent buildings can generally be more or less applied in the field; and, if a pressure for hospital accommodation should arise, it will be better to provide temporary structures, arranged in accordance with recognised sanitary principles, rather than to occupy houses which do not fulfil the conditions requisite for the preservation or restoration of health.

American military hospitals.

This was the opinion of the sanitary commission of the United States, and was acted on by the Government of that country, in the provision of hospital acccommodation on the very large scale required to provide for the reception of men disabled during the civil war.

Some idea of the vast extent of the operations of the sanitary administration of the United States army may be formed from consideration of the fact that in August 1864, the number of hospitals was 214, and that accommodation was provided for 133,800 beds, of which 97,751 were occupied.

The American hospitals were generally made up of a number of wooden huts containing from thirty to sixty beds, the construction and general arrangements being in accordance with the principles laid down by the British Commission of 1857.

The annexed Diagrams, Figs. 1 and 2, will, better than any written description, convey an idea of the mode of construction adopted. It represents only a single ward. The number and arrangement of wards are varied in each case. The offices for administration and accommodation of the hospital staff, &c., were provided in separate structures.

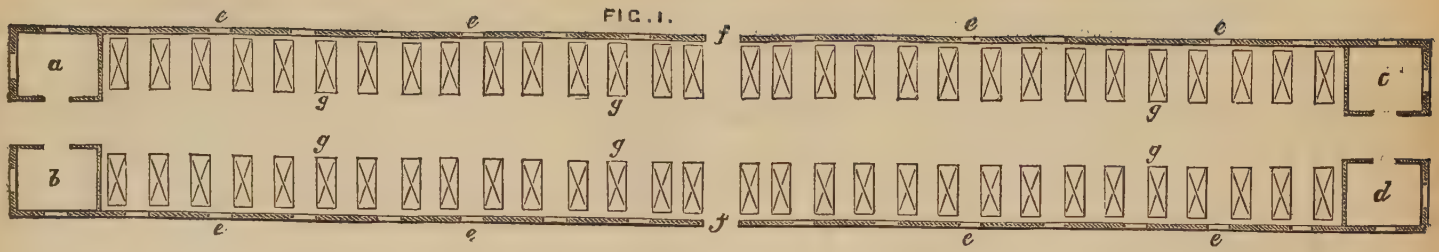
Detail of construction. Hospital buildings.

The following are the principal features of the mode of construction which has been generally approved for military hospitals :—

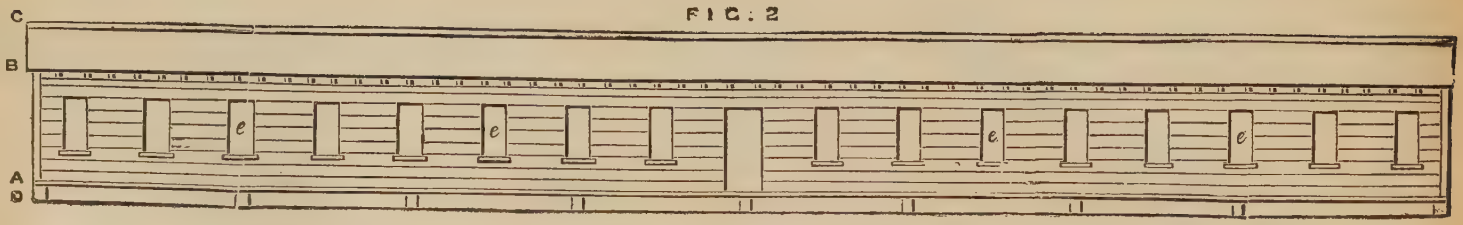
1. The arrangement of the wards in pavilions is that which is considered to carry out most fully the principles of isolation and ventilation from the outer air.

Hospitals for any given number can be built on this system, and it has the advantage of being readily adapted to any form of site, but it requires a considerable extent of ground in order that the pavilions may be completely separated from each other.

2. General hospitals should be made up of a number of independent pavilions, arranged according to the nature of the ground, and connected for administrative purposes in



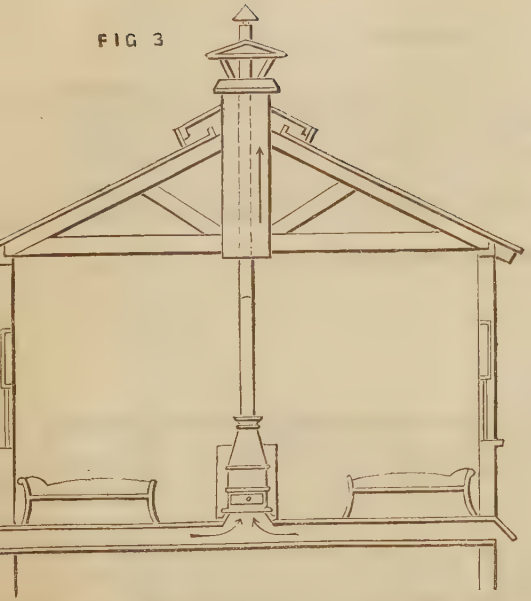

PLAN.




HOSPITAL PAVILION ON THE CONSTRUCTION ADOPTED BY THE UNITED STATES GOVERNMENT.

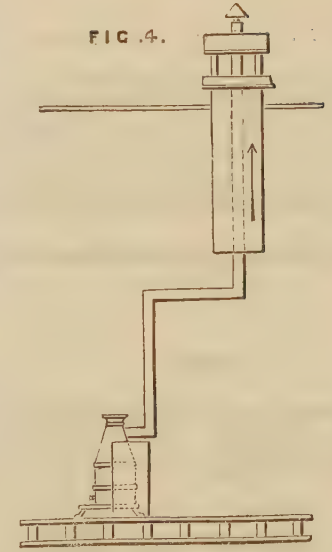
ELEVATION.

FIG 3



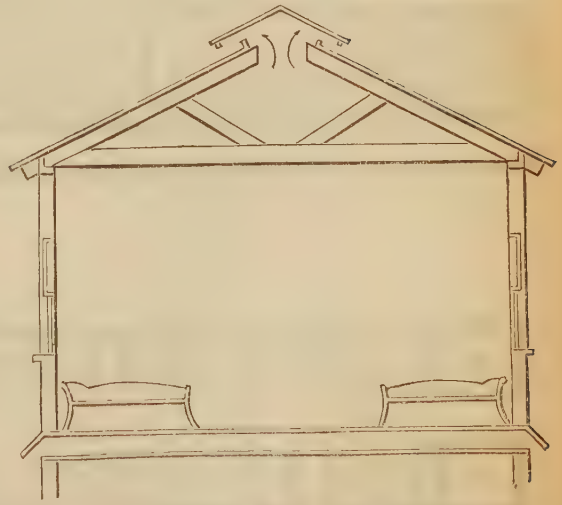
SECTION SHOWING THE MODE OF VENTILATION IN WINTER.

FIG 4.



SIDE VIEW OF STOVE.

FIG 5.



SECTION SHOWING THE MODE OF VENTILATION IN SUMMER.

HOSPITAL PAVILION ON THE CONSTRUCTION ADOPTED BY THE UNITED STATES GOVERNMENT.

such a manner as to prevent the emanations from one pavilion passing into another.

3. No pavilion should contain more than two floors of wards, and it is very desirable that the pavilion should run north and south, so that as large a surface of the building as possible may be exposed to the sun.

4. Hospital wards should not contain more than thirty-two beds; the width should not be less than 24 ft.; the height 14 ft.; the wall space not less than 7 ft. 3 in. per bed, which will give a superficial area of not less than 87 ft. and a cubic space of 1,200 ft. for each patient. In tropical climates the cubic space should not be less than 1,500 ft.

5. For lighting and ventilating wards the arrangements which have been recommended are as follow:—Windows, to open at top and bottom, to be provided on opposite sides of the wards, the beds being arranged between the windows. Inlets to be provided between the windows for fresh air, and flues for carrying off heated air, both inlets and flues being near the ceiling. The total sectional area of the outlets to be from 10 to 15 square inches per patient, according to the heights of the flue.

6. The grates for hospital and barrack purposes shown in the War Department building deserve special attention. These warm the rooms partly by direct radiation and partly by warming slightly a large mass of fresh air taken from the outer atmosphere. The air is led by means of horizontal flues, to a fire-brick chamber behind or around the grates, and thence disseminated through the rooms by flues and inlets arranged for the purpose. In hospitals the grates should, if possible, be placed in the centre of the ward, the smoke flue being carried horizontally under the floor, and the flue to warm fresh air admitted along its side and led to the fire-brick chambers in the stove, whence it passes into the ward.

7. Suitable offices should be provided for each ward, the closets and sinks being of the best construction, efficiently drained, and cut off from the wards by a ventilated lobby.

An arrangement of a building with this object is shown in the type of a ward which forms part of the building erected in the park by the British War Department.

8. Among the important items of hospital construction must be classed the apparatus for cooking, which will be noticed in the report on Class 20.

9. The walls and ceilings of wards should be lined with parian cement, or other material which will not absorb

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moisture containing organic matter, and which can be cleansed by simple washing.

10. The windows of wards should be glazed with double or plate glass, for the purpose of saving heat.

11. The upper half of the doors in large wards should be glazed, so as to facilitate inspection.

12. It is desirable that hard wood should be used for floors, doors, &c.

Barrack buildings.

The sanitary principles which govern the construction of wards for the reception of sick are also applicable to barrack rooms intended for ocupation by a number of men in health, the details should therefore be arranged with reference to the numbers to be accommodated and the amount of expenditure which it may be intended to incur.

It is desirable that in each country a unit of size should be laid down for barrack rooms, the numbers accommodated bearing a certain proportion to the strength of a regiment or corps; and that barracks of any given size should be constructed by simply increasing the number of units.

The following are details of some of the improvements which have been effected in barrack construction within the last few years:—

1. Barrack rooms are constructed to contain from 20 to 30 beds, with a wall space of not less than 5 ft., and a cubic space of not less than 600 ft. per bed; the height of the rooms being from 11 ft. to 12 ft.; breadth, 20 ft. to 22 ft.; windows equal to about half the number of beds, arranged on opposite sides of the room.

2. Serjeants' rooms open from the passage or landing leading to the barrack room; and at one end of the latter, and separated from it by a ventilated lobby, are placed the necessary ablution rooms, &c.

3. The means of ventilation and the lighting of barracks generally have been very materially improved. Kitchens, cleaning rooms, and offices are built away from the barrack-rooms. Cooking ranges of improved construction, which consume a small quantity of fuel, are provided, and the men are instructed in cooking by sergeants specially trained for the purpose.

4. Day rooms, well lighted, plainly but comfortably furnished, and supplied with games, newspapers, &c., are provided. The day rooms are, in the latest plans, placed near the canteens, and liberty is allowed within reasonable bounds for recreation and for obtaining refreshment, so that soldiers are no longer driven to resort to public houses. Facilities are afforded to the troops for managing their own canteens

and for appropriating the profits to regimental improvements. MAJ. LEAHY ON MILITARY HOSPITALS &c.

5. Schools, workshops, and drill sheds are provided. Gymnasia are being gradually constructed in all large barracks, gymnastic exercise being made a part of the ordinary drill.

6. Special quarters are constructed for married soldiers, and also houses and apparatus for washing linen.

In respect of cavalry stables, a consideration of the various existing buildings has led to a recommendation that the construction best suited for preserving the health of horses is one in which the following conditions are observed :— Cavalry stables.

1. An arrangement of the stalls which admits of the perfect lighting and ventilation of each. The stalls are usually arranged on each side of the building, with windows above each, and air-bricks admitting the outer air are placed at a low level, so as to afford fresh air to the horse when lying down at night.

2. Open roofs, partially glazed, and with ventilators in the ridge. Lofts or other constructions over the stalls are objected to as interfering with ridge ventilation.

3. A wide central passage between the stalls.

4. Provision of impervious paving, drainage being effected by means of shallow open drains with rapid slopes, and not by covered drains or cesspits.

Two stalls of approved construction may be seen in the British War Department Building.

## Field Hospital Equipments.

FIELD HOSPITAL EQUIPMENTS.

Of the military equipments exhibited none are more calculated to excite general interest than the collection of means for the relief and medical treatment of sick and wounded soldiers exhibited in the park, between the Porte de l'Université and the grand entrance from the Pont d'Jena.

The buildings in which the collection is placed are distinguished by a flag bearing a red cross on a white ground, being the badge laid down in Act 7 of the Convention of Geneva, dated Aug. 22, 1864, as the distinctive mark of the hospitals and their personnel, which are, under that treaty, recognised as neutral.

The collection has been made under the auspices of the "Société de Secours aux Blessés Militaires," an international society, formed with the object of relieving, in all possible Société de Secours aux Blessés Militaires.

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ways, soldiers who may have been wounded in action, or who may have contracted sickness during active military operations. The society originated in suggestions arising from the insufficiency of the military arrangements for the relief of soldiers wounded during the Italian campaign of 1859, and more especially at the battle of Solferino. It is guided in its operations by the principles laid down at an international conference held at Geneva in October 1863, and by regulations embodied in the Geneva Convention of 1864.

Geneva convention. 1864.

The conference of 1863 was brought about by a committee of the "Société d'Utilité Publique," of Geneva, of which M. Dunant, the author of a work entitled "Un Souvenir de Solferino," was the promoter and secretary. It contemplated the formation of national committees to minister to the necessities of wounded soldiers, and to supply and maintain in time of war volunteer attendants in aid of the military administration of armies in the field.

The convention of 1864 has facilitated the working of these committees by establishing the neutrality of field hospitals, equipments, military hospitals in actual use as such, and of the sick and wounded therein. It also provides that the hospital attendants and the personnel employed in the transport of wounded shall, while non-combatant and solely occupied in those capacities, participate in the neutrality. Private houses devoted to the accommodation of wounded are also to be respected, and inhabitants who assist the wounded are to be protected and exonerated from a share of the contributions of war which may be imposed.

It was part of the project of the originators of the movement to give the national committees a status during a campaign, independent of the military administration; but this suggestion was likely to be attended by so much inconvenience, and gave rise to so many objections, that it was not noticed in the convention, which only recognises the neutrality of *military* hospitals and their personnel, including, of course, the volunteer attendants acting under military regulations and officially recognised by the general officer in command of the army.

The whole of the great European Powers have now signed the convention; and the fact that within the last year Austria and Russia have become parties to it would appear to prove that its principles are consistent with the most autocratic military system.

The medical regulations of the French army contemplate the assistance of the "Société de Secours aux Blessés Militaires," in aid of the military administration.

Acting on resolutions agreed to at the conference of 1863, national committees of the society were formed in most of the European States, and those of Prussia, Austria, and Denmark were called upon to practically discharge their functions during the campaign of 1865.

Prussian committee.

The good results attending the operations of the Prussian committee during the campaigns of 1865 and 1866 have gained for it the special patronage of the Government, the Queen and Crown Princess taking personal interest in the subject.

The committee, besides furnishing each army corps with a proportion of volunteer nurses (more than 600 Prussian ladies acted as such), procured with funds raised by voluntary subscriptions supplies of medical comforts, dressings, &c., to the value of over two million of francs. These supplies were periodically despatched, under the personal direction of members of the society, to the different theatres of war, and were there dispensed to wounded and sick soldiers without distinction of nation.

Committee proposed to be formed in England.

The formation of a corresponding committee in England has been advocated, and is much to be desired. Objections have been made to the proposal on the ground that it is the duty of the Government to provide the military hospitals with all that is necessary, and that, if private individuals were to organise themselves for the purpose and allowed to assist, the responsibility of Government would be lessened.

As the volunteer forces have been recognized and organised as auxiliary to the regular troops, so, it is conceived, might a national branch of the "Société de Secours aux Blessés Militaires" be recognised and encouraged as auxiliary to the military medical administration.

The assistance of the volunteer nurses might be very valuable in the "temporary hospitals" established during a campaign, and which occupy a position intermediate between the "field hospitals" (or "ambulances") which accompany the troops and the "general hospitals" established in buildings specially constructed or adapted for the purpose.

The want of means for promptly removing the wounded from the field of battle has added largely to the suffering and mortality resulting from recent wars; and occasions are likely to arise during a campaign on which any amount of volunteer assistance would be acceptable. The number of wounded left in the hands of the allies after the battle of Solferino was 20,000, the total loss of the French alone having been about 1 to 11 of the soldiers engaged. At Sadowa there were more than 18,000 wounded scattered

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over the field of the engagement extending from Sadowa to Clum, and from Nechanitz to Königsgratz.

It will readily be conceived that to attend so large a proportion of wounded would overtax any military hospital force that could be maintained as accessory to the combatant troops; and there is no more difficult problem in army administration than to organise a hospital personnel and equipment which, while not too costly or cumbersome, will be equal to the emergencies that may arise.

It has been estimated by some that the lives of 40 per cent. of those who have perished on the field of battle in recent wars—many from thirst, hunger, or cold—could have been saved, had it been possible to remove them without delay to places where their wants could have been attended to in safety. The aid of intelligent persons willing to assist, under military regulations, in the arrangements for the first dressing of wounds, and the speedy and careful removal of the wounded to the ambulances, should not, therefore, be declined.

Articles exhibited.

The "exhibits" of ambulance equipments to accompany an army in the field comprise medicine chests, medical appliances, instruments for medical officers, stretchers, litters, cacolets, ambulance conveyances, &c. of patterns which have been used during the last European and American wars, as well as others shown by the French and English Governments, and by manufacturers and persons interested in the subject.

A large and very interesting section of the collection made for the "Société de Secours," has been exhibited by Dr. J. W. Evans, an American surgeon-dentist practising in Paris, who has taken great interest in the subject, and who has devoted much time to the study of military medical regulations, and of their working in time of active warfare. Dr. Evans' collection consists chiefly of examples of equipment actually found to be useful during the American war.

Count F. de Breda, one of the secretaries of the Society, has, with the assistance of M. Arrault, collected, for the consideration of the international committee, a large number of objects of the patterns which appeared to him to be most worthy of consideration.

Messrs. Fischer & Co., of Heidelberg, who are largely engaged in the manufacture of hospital appointments, have exhibited a large number of litters and apparatus for the removal of wounded, and of other appliances which have been proposed or manufactured by them for the national committees which have been established in Germany and Austria.

Messrs. Charriere & Mathieu of Paris, Locati of Turin, Basbieri & Co. of Naples, and many others, have contributed to the collection. MAJ. LEAHY ON FIELD HOSPITAL EQUIPMENTS.

The whole of the articles are being examined in detail by an international committee of the Société de Secours, which has been charged with the task of proposing, with a view to its adoption by the national committees, a model equipment, which shall combine the best points of the patterns exhibited and satisfy the requirements laid down by competent authorities. As this committee includes among its members military medical officers, delegated by the Governments of the principal Powers, it may be expected that military ambulance equipments will be organised on the model which may be eventually approved by the Society.

The several articles may be classed as follow :— Classification of articles.

I. The appliances for dressing wounds on the field of battle, and for the removal of wounded men to the field hospitals, which are usually established immediately in rear of the armies engaged.

II. The equipment of field hospitals or "ambulances," and the conveyances specially constructed for the removal of sick and wounded during the march of a column, or to a fixed hospital or ship.

III. The means for removing sick and wounded from temporary to general hospitals by railway and other land conveyances.

## Class I.—Articles used on the Field of Battle.

The medical appliances to be taken on to the field of battle should be selected with reference to operations which are necessarily there performed, and ought not to include the medicines, &c. required for treatment of disease, or the appliances required for the more difficult operations which are best performed in the hospitals. Medical appliances.

There are several examples of field medicine canteens adapted for pack transport exhibited, but attention is more especially directed to the two army medicine panniers exhibited by the British Government, and to the model pannier proposed by Count Breda. Medicine panniers.

The former are baskets covered with hide, and together contain a very complete assortment of medicines and of medical appliances and comforts. The contents are conveniently arranged and securely packed, but they have not been selected with special reference to the requirements of

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the wounded. Bottles containing poisonous drugs are constructed so as to be readily distinguished from those holding more simple preparations. The panniers will form an operating table: their weight is 180 lb. In connection with them is shown a "Medical Field Companion," a kind of pouch containing a small assortment of medicines and dressings. The weight of this pouch is 11¼ lb., and it is intended to be carried by hospital attendants.

The panniers in Count Breda's collection have been arranged by M. Arrault. Each is complete in itself, and, besides instruments and medicines, contains dressings for 250 wounds, the linen, lint, &c., being compressed so as to occupy about half the space usually required. The cases are made of wickerwork and covered with leather; they are lighter than wooden canteens, and they afford more security to the contents. It is said that one of those exhibited has been thrown from a second-floor window without injury to the bottles therein. The weight of each pannier complete is about 90 lb.

In addition to the panniers M. Arrault has arranged knapsacks to contain the dressings, &c., more immediately required on the field of battle, and intended to be carried by the hospital attendants of infantry regiments. The knapsacks weigh 16 lb., and contain dressings for fifty wounded.

Count Breda also exhibits a model pack equipment for mounted hospital attendants. The saddlebags are arranged to carry an assortment of dressings, &c., similar to that in the knapsack of the infantry attendant. The appointments can be used as draught harness, and the shabrac and saddle be applied so as to form a kind of tent. The appointments of this equipment are the invention of M. Cogent, retired captain in the French cavalry, and some special advantages are claimed for them. The saddle is said to be strong, very light, cheap, and well adapted to cavalry service. Its framework is made of rolled iron, and so formed that it can be adjusted to any horse.

A medical pouch, intended for small detachments which are not accompanied by medical officers, is worthy of attention. Among the instruments for which merit is claimed is a "coupebotte," or knife for cutting off the boots of men wounded in the foot.

Litters.

For the removal of wounded from the field of battle a great number of contrivances have been proposed and exhibited; but a large proportion are wanting in qualities desirable for the purpose. There is no one example which

combines all the conditions desirable in a litter, and which may be stated to be,—

(1.) Simplicity of construction, with means of taking to pieces, so as to facilitate transport and the replacing of damaged parts.

(2.) Lightness, so far as is consistent with strength; capability of being carried by one man.

(3.) Means of placing the appliances on wheels, with good springs or suspension, so as to travel over rough ground with easy motion, and thereby facilitate and expedite the removal of wounded.

(4.) Cheapness and durability.

It is questionable whether a litter can be devised to combine these qualities, and it is probable that two kinds may be required for field service.

Hand litters.

Of the simple stretchers exhibited, there are none which appear better adapted to field service than the English War Department bearer, consisting of two poles and canvas sacking. It is strong, light, and cheap. The canvas can be easily detached, cleaned, or replaced; and by a simple arrangement the stretcher can be placed on legs, so as to form a bedstead.

Wheeled litters.

No litter, however, can be altogether satisfactory which requires two men for the removal of one; and attention is now being directed to wheeled litters, by means of which the wounded may be moved more rapidly and with less fatigue by half the number of men required for carrying the ordinary stretcher, and with greater safety and care than by mule litters.

Neuss's litter.

In the Prussian section of the "Société de Secours" collection is shown a wheeled litter, constructed by Messrs. Neuss, of Berlin, which was used in the campaigns of 1865-66, and which is made of canvas stretched between two light wooden poles, and placed on springs affixed to an iron axle. The side poles are provided with handles at each end, so that the litter may be drawn, pushed, or lifted. It is provided with a hood to form a protection against rain, and props are attached to the poles, by means of which it can be supported in a horizontal position when at rest. Litters of this pattern were used to transport wounded from Düppel to Flensborg (a distance of about 25 miles) in 1865, and it is said that a number were supplied to the French army in Mexico, and were there considered to have advantages over the mule litters used in the French service. The litters of Messrs. Neuss are light (weight about 110 lb.), but do not admit of being packed in a small space, and are not so simple in construction as desirable.

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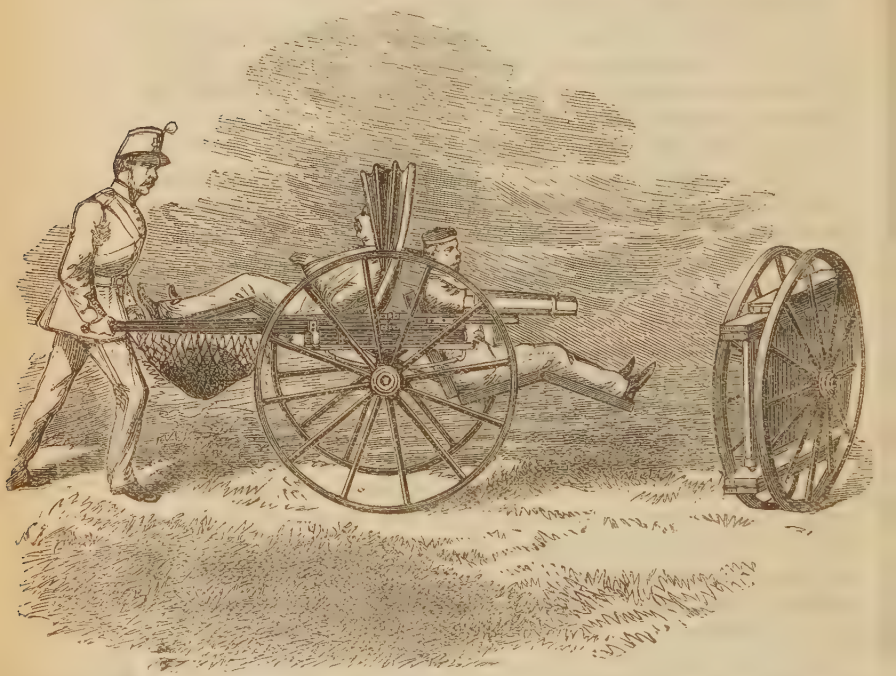
A wheeled stretcher will be found in Count Breda's collection, but it has no springs, and admits of many improvements in detail.

Messrs. Fischer and Co. exhibit a wheeled litter, which will carry two men, one lying, the other sitting. Conveyances of this kind (see Engraving) were proposed by Dr.



NEUDORFER'S TWO-WHEELED LITTER CONVEYING TWO WOUNDED SOLDIERS.

NEUDORFER'S LITTER FOLDED AND PACKED FOR CARRIAGE.

Neudörfer, an Austrian military surgeon, and were used, it is said, with success in the Schleswig-Holstein campaign of 1865. The example shown appears to be too complicated and expensive for military purposes, and it would not be easy to place a helpless patient in it. It is more economical in labour than Neuss's litter, and if the construction could be simplified might perhaps be advantageously used.

The British War Department shows a jointed stretcher, with hood, which can also be used as a chair or bed. This, if placed on wheels, would be a good type of litter.

Mr. Redford, M.R.C.S., London, exhibits a model of a portable stretcher, which has been honourably mentioned.

Messrs. Deane, of London Bridge, exhibit a stretcher

forming also a bedstead or easy chair which deserves attention.

The stretcher mattrass in the English ambulance wagon is one of the best of its kind; it is provided with springs, and fitted with rollers to facilitate its insertion into the carriage. The springs, the material used for covering the mattrass, and other details could be improved.

The American stretchers do not differ materially from the English patterns, and can equally be improved upon.

Dr. Landa, of Milan, proposes that hospital attendants shall wear a canvas apron, which can be used for carrying wounded.

Numerous other devices for carrying wounded are exhibited; but, on practical trial, many failed to satisfy the conditions required as to strength, &c.; and others are too costly for field service.

## Class II.—Equipment of Field Hospitals or "Ambulances."

This class comprises medicine wagons or carts, ambulance wagons specially constructed for conveyance of sick, and mule litters. Hospital tents also form an important element in the ambulance equipment, and examples are exhibited by Dr. Evans and by the "Société de Secours" (Prussian Section).

Medicine wagons.

The medicine wagons in the collection of Dr. Evans are deserving of attention, particularly that known as M. Perot's, said to have been largely used during the war in America. In this wagon the drawers and compartments are adapted to the carriage of medicines in bulk or in bottles, and by an ingenious arrangement the latter are secured from fracture. A spring is placed under each bottle, which secures it in the compartment allotted to it, and admits of its being readily taken out and replaced. The rear of the wagon is so constructed as to shelter the surgeon while dispensing. A set of hand litters, and an amputating table, are carried.

Count Breda exhibits a model of a medicine cart, the peculiarity of which is, that it is constructed so that medicines and appliances shall be arranged in boxes or knapsacks (as before described), containing assortments applicable to a certain number of wounded.

The English medicine cart, of which an example is shown, is used to carry hospital tents, bedding, cooking, and other utensils for twenty patients; also boxes containing medical comforts and appliances, examples of which are exhibited.

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Ambulance wagons.

The cart weighs 830 lbs. when empty, and 2,240 lbs. when loaded. The English ambulance wagon weighs 1,624 lbs. including fittings; it will carry eight wounded, two lying and six sitting. This as well as the store cart differ in but few details from the ordinary transport wagons and carts, the wheels and framework being of a very substantial character.

The ambulance conveyance in general use in the French army is also an adaptation of the "Voiture unique" in that service, and differs, it is believed, but little from that exhibited in the British section, being if anything heavier.

This wagon, however, is not exhibited, and the French Government shows two ambulance conveyances now in use experimentally, viz., a two-wheeled cart weighing 650 lbs., intended to be drawn by one horse; and a wagon weighing 2,050 lbs., to be drawn by two horses.

The use of two-wheeled carts is attended with disadvantages, which render it undesirable to adopt them in a model ambulance equipment. In the first place, the motion is most unfavourable for the transport of wounded; and, if the cart were to proceed at a pace quicker than a walk, might be intolerable. Secondly, there would be a great risk of serious accidents to the wounded if the horse were to stumble or the shafts to break.

The new pattern wagon shown by the French Government is simply a bad omnibus. It will carry ten sitting, or two men sitting and two on stretchers. It does not appear to possess any of the qualities peculiar to a good ambulance conveyance, and which may be stated to be as follow:—

1. Very easy motion.
2. Convenient arrangement of beds and seats, with sufficient space and ventilation.
3. Facility for mounting and for inserting the stretchers on which badly wounded men could be placed.

It is also very desirable that wagons specially constructed for conveyance of sick should be light, so as not to require, under the ordinary circumstances of a campaign, more than two horses; and that they should admit of being easily turned in a small space. It is a question whether they should not be driven from a seat rather than by a postillion.

A suitable four-wheeled wagon, which could carry two, or, on an emergency, four, men lying and three sitting, or which could be arranged to carry a larger proportion of men sitting, might, it is conceived, be devised.

American wagons.

Of the special conveyances exhibited, none possess the conditions desirable in ambulance conveyances to a greater degree than those used in America, examples of which are shown in Dr. Evans' collection, and by the Government of the United States. These wagons are of the character of light four-wheeled carriers' carts, with extra springs and seats to adapt them to the particular use for which they are intended to be applied. It is said that this class of conveyance was adopted after the trial and failure of the heavier description still in use in France and England. Five wagons, being types of those used during the American war, are exhibited.

The Howard ambulance wagon, a light, two-horse, four-wheeled carriage, is designed to carry four persons (two recumbent and two sitting), or eight sitting, besides the driver; it is said to weigh 1,200 lbs. The body of the wagon is mounted on elliptic springs, and the stretchers and mattrasses are fixed on a second set of "counterpoise" springs inside the carriage, which are said to modify or altogether prevent concussions, and contribute greatly to the safety and comfort of the patients transported. There is also connected with the wagon a sling for the suspension, if necessary, of wounded limbs. The cover is of canvas, and admits of perfect ventilation. The stretcher mattrasses are furnished with rollers, so that the severely wounded are placed in and removed from the carriage with but little disturbance. This wagon does not turn in as small a space as desirable; the seats are not sufficiently wide or deep, and it is difficult to get into them.

Dr. Evans also exhibits a wagon, called "the wheeling ambulance," of a kind extensively used by the Government of the United States during the war; but with improvements proposed by Mr. Perot, of Philadelphia. The improvements comprise the application of springs of caoutchouc attached to levers springing from the axletrees, so as to give easy movement. India-rubber springs are not, however, found to answer in very hot climates.

A wagon made by Brainard, of Boston, will carry four persons recumbent or ten persons sitting; and the example exhibited was used for hospital service for several months.

Another wagon is one of thirty given by the citizens to the firemen of Philadelphia, who volunteered to convey the sick soldiers across the city from the Baltimore to the New York station, a distance of four miles. Three thousand soldiers were transferred from station to station by these conveyances.

An American wagon (Rucker's) is worthy of notice. It

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differs in some details from the Howard ambulance wagon; and, in place of the "counterpoise" springs inside, has a second set of springs underneath. It will carry four persons lying, and is said to weigh 1,400 lbs.

It will be noticed that all the American wagons are light, drawn by two horses, and driven from a seat. They carry from four to ten persons besides the driver.

Locati's hospital carriage.

The Italian committee of the "Société de Secours" exhibit an hospital wagon, designed and constructed by Mr. Locati, a carriage builder at Turin. This carriage is an omnibus with coupé and driver's seat in front. The coupé will hold three persons sitting, and in the interior may be placed five patients recumbent, one on the floor and two on each side. The upper bed on each side can be lowered by means of a handle in rear of the carriage, so as to admit of the patient being placed on it more easily. The interior can also be arranged so as to carry five sitting and two recumbent or ten sitting. In boxes attached to the carriage are stowed the medicines, medical comforts, and utensils necessary for the number of patients conveyed, so that the conveyance forms a complete travelling hospital. It is said that carriages constructed after this model were used to transport a large proportion of the badly wounded volunteers who served in the Tyrol during 1866, and that when used for ten persons they were easily drawn by two horses.

Swiss wagon.

An ambulance wagon exhibited by the Swiss committee deserves notice. It consists of a platform on low wheels, and can be arranged so as to carry four persons lying or twelve sitting. The carriage is well suspended and is said to be light of draught; but it is a question whether the small front wheels would not make its motion very uneasy on broken ground.

The ambulance wagon fitted up for the head-quarter equipment of the King of Prussia during the campaign of 1866 is exhibited; but as it is specially fitted and adapted for only one person it is not a fair type of the conveyances for army service.

Mule litters.

There are occasions when, owing to the absence of roads or tracks for wheeled carriages, it is necessary to employ pack animals for general army transport, and consequently for the conveyance of sick and wounded. This was the case during the first occupation of Algeria, and it is still necessary to have recourse to pack transport for supplies sent to the advanced posts in that colony. In reference to this necessity the French some years since organized a very complete field ambulance, the stores for which as well as

the sick are carried on mules specially trained and selected for that purpose. The mule train for an expeditionary column of one thousand men usually consists of forty-nine animals, each led by an hospital attendant or soldier of the train; of these sixteen are allotted for the conveyance of equipment and thirty-three for that of sick.

There are two kinds of mule litters, the "cacolet," so called from its resemblance to the contrivances used in conveying milk ("caque au lait") and the "litières." The former is a kind of armchair, one being slung at each side of the pack saddle, in which the sick or wounded soldier sits upright. The second is a couch, similarly carried, in which the man lies down, and is protected from sun or rain by a hood.

Examples of "cacolets" and "litières" are exhibited in the French, Italian, Portuguese, and American collections; but this kind of transport is not looked upon as a model, except in cases where wheeled transport cannot be made available. For removal of wounded from the field of battle on cacolets a large proportion of attendants and well-trained animals are required, and loss of time results from the operations necessary in placing the wounded on the animals, especially if the mules are in any degree restive. For transport on the march the motion of cacolets is probably easier than that of the old type of ambulance wagon, but not so much so as that of the improved models.

## Class III.

For the conveyance of invalids from the temporary hospitals which are established during a campaign to their homes, or to the general hospitals, use has to be made of the ordinary transport wagons by which the supplies of food, &c. are brought up for army service, it is therefore desirable to contrive arrangements by which such conveyances or railway carriages may be made fit for the conveyance of sick. With this view it has been suggested that each invalid shall be provided with a spring litter to be placed in the wagon, or that the litters should be suspended in some way, probably by interior springs similar to those of the Howard ambulance wagon.

Railway conveyances.

The Baden committee of the Société de Secours exhibits an arrangement for suspending the litters in railway carriages, and M. Locati, of Turin, submits a plan for fitting up a third-class carriage as a hospital wagon.

The most interesting example of this class of conveyance is a model of the hospital railway cars used by the United

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States Sanitary Commission, and exhibited by Dr. Evans. The model (on scale of $\frac{1}{4}$) is a facsimile of a "sanitary car" in all its details, and shows couches, dispensary, closets, means of heating and ventilation; externally it represents an ordinary American passenger car. In cold weather the cars were heated by stoves, and fresh warm air was introduced from ducts leading into the carriage near the stove.

Among the vehicles exhibited in the United States collection is a cooking wagon patented by J. Dunton, Philadelphia.

Coffee wagon.

It is intended for carrying a supply of tea, coffee, sugar, and condensed milk, and for cooking these articles on the line of march or in camp. From 45 to 60 gallons of coffee or tea can be boiled at one time in the wagon exhibited, which is also of interest as having been used on the day of the surrender of General Lee to supply hot coffee to the wounded of both armies.

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Military Telegraphy.

## Military Telegraphy and Signalling.

Great importance has at all times been attached to the arrangements for conveying intelligence with accuracy and rapidity during active warfare, but the influence of these arrangements on military operations has been largely increased by the use which may be made of railways in the movements and concentration of troops.

The introduction of railways for ordinary travelling and transport rendered necessary an improved system of signalling, and led to the development of the electric telegraph as being incomparably the quickest and most accurate means of conveying intelligence.

Electric telegraph used in recent wars.

The English Government was among the first to acknowledge the advantage which might be derived from using telegraphs for military communications, and an equipment intended to accompany the army while on the march was sent out to the Crimea in 1854. There was not, however, any opportunity of testing its fitness for that purpose, and the *matériel* was used for establishing communication between the British head-quarters and the ports of Kazatch and Balaklava. A light submarine cable was subsequently laid across the Black Sea from Varna, and the lines of telegraph were extended to the camps of the different divisions and to the trenches, so that there was uninterrupted telegraphic communication between the latter and London.

The Austrian Government took steps in the same year, 1854, to organize a military electric telegraph equipment.

During the Indian mutiny, 1857–8, the telegraph wires were laid so as to keep pace with the advance of the Commander-in-Chief, and were of essential service in keeping up communication with the seat of Government. In this case the necessary equipment was improvised under the direction of the late Lieutenant-Colonel Stewart, R.E., to whom great credit was accorded for the excellent arrangements made under difficult circumstances.

Military telegraph train being organized.

The French, during the war in Italy in 1859, turned the telegraphs of the country to account in keeping up communication along the line of operations and with their base. In the civil war in America the telegraph was very largely used by both armies, and regularly organized telegraph trians accompanied the Prussian and Austrian armies in 1866. The advantages derived from the use of telegraphs during these wars has led to the formation of equipments specially adapted to military telegraphy and to the organization of telegraph trains in nearly every European army. The military telegraph department of the British Army is now being reorganized, and a school for telegraphy and signalling has been formed as a branch of the school of engineering at Chatham. The estimates of the present year include a vote for an experimental equipment, and it may be expected that ere long an established equipment and a proportion of telegraphists will be attached to every army division or mixed military force.

Electric telegraph.

Although the electric telegraph possesses many advantages over other systems of conveying intelligence when the communications are secure, it is liable to interruption, and cannot be trusted in cases where the lines of wire pass through a country the population of which is unfriendly. It also requires some time, labour, and transport for establishing the first communications.

Signals when used.

For these reasons it is frequently necessary to have recourse to signalling for communicating between bodies of troops, and no military telegraph equipment is complete without means of extending the communications by signals when there would not be appliances or time to lay down a line of wire.

For communicating between an army and fleet signals are indispensable, and for this purpose fixed signal stations should be provided at every maritime fortress.

Troops can be manœuvred by means of signals, and their application for this purpose, will, it is expected, become

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more general, as, owing to the distance at which armies may now be brought into action and the length of the lines of battle, it will probably be found that orders, preliminary to the engagement, can be conveyed more conveniently and expeditiously by means of signals than through the agency of mounted officers or orderlies. Signalling was extensively used for this purpose during the civil war in America.

A regular system of signalling is now being devised for use in the British Army, and it is intended that a proportion of men in each regiment or corps shall be instructed to act as signalmen.

There are two examples of signal apparatus shown in the Paris Exhibition :—

1. The Austrian signal post, in the military collection of that country, Gallery No. 6.

2. Bolton and Colomb's flashing signals, in the British Admiralty shed.

Austrian signal apparatus.

The Austrian apparatus, as exhibited, consists of a pole about 20 ft. high, with a cross arm about 2 ft. 6 ins. from the top and three discs of about 12 ins. diameter, arranged in the form of an equilateral triangle at the top. The two lower discs are moved by one handle and the top disc by another, so as to turn either surfaces or edges to the front. The message is transmitted by displaying the surfaces or edges in various positions. This apparatus, which has been designed by Baron von Ebner, is used in fortresses and in the field. The field apparatus can be carried complete in an ordinary wagon. For fortresses the height of the poles and the size of the discs can be regulated by the distances at which the apparatus is required to be seen. For night signalling lamps placed on stands in rear of the discs are used. It is claimed that the use of three discs facilitates the communication ; but, on the other hand, an alphabet different from the Morse or other telegraph alphabet in common use has to be employed.

Bolton and Colomb's signal apparatus and system of signalling.

Bolton and Colomb's signal apparatus gives the means of conveying signals by long and short flashes, corresponding with the dots and dashes of the Morse alphabet. The system is equally available for permanent signal stations or for field service, as it has already been adopted by the Royal Navy, and it will probably be also used for our military signalling. With good operators and apparatus messages may be transmitted with considerable speed ; seventeen words per minute is stated to have been attained.

Flashing signals are made by the successive appearances and disappearances at regulated intervals of lights or objects,

in a manner precisely similar to revolving or flashing lights in lighthouses.

The appearances of the light or object are termed "flashes" and are of two lengths, termed respectively "short" and "long" flashes, which are used in combination to express the signs required. The long flash is usually about a second and a half in duration and the short flash about half a second.

In the daytime the different apparatus shown in figures 1, 2, and 3, may be used, under the varying circumstances of service. At short distances no apparatus is necessary, the simple waving of the arm, with a hat, flag, handkerchief, &c. being perfectly efficient; or the flashes may be represented by long and short sounds, of a fog horn for instance.

Day signal apparatus.

Fig. 1 represents a collapsing drum, which is used for distant and other signals in the daytime; A shows the drum extended by the line *c*, representing an exposure of the light; and B the drum collapsed, representing a concealment of the light.

The drum is to be hoisted where most convenient; 20 ft. is a sufficient height for the most distant signals; it is self-collapsing, and is worked by hand.

Fig. 2 represents an apparatus which consists of a pair of collapsing cones, on a staff, fitted on a principle resembling the opening and closing of an umbrella. A shows the apparatus closed and B open.

Fig. 3 represents an apparatus to be used for permanent stations. It may be made of any size, corresponding to the distance required to transmit signals. An apparatus exposing a surface of 72 sq. ft., as at B, gives a range of 15 miles in clear weather. It consists of a series of shutters, each working on a pivot, and all connected together in such a manner as to move simultaneously by the motion of the handle *c*. When the shutters lie horizontal, as at A, representing the obscured state of the light, an observer sees nothing, as, at a short distance, the light skeleton frame is unseen; but when the shutters lie vertical, as at B, representing an exposure of the light, a very large surface comes into view. Signalling by this apparatus may be carried on with great rapidity, as the appearances and disappearances may be produced a hundred times in a minute with ease. If this apparatus is used against a dark background, the shutters should be kept whitewashed, and the framework painted black; otherwise the shutters are to be painted black and the framework white.

FIG. 1.

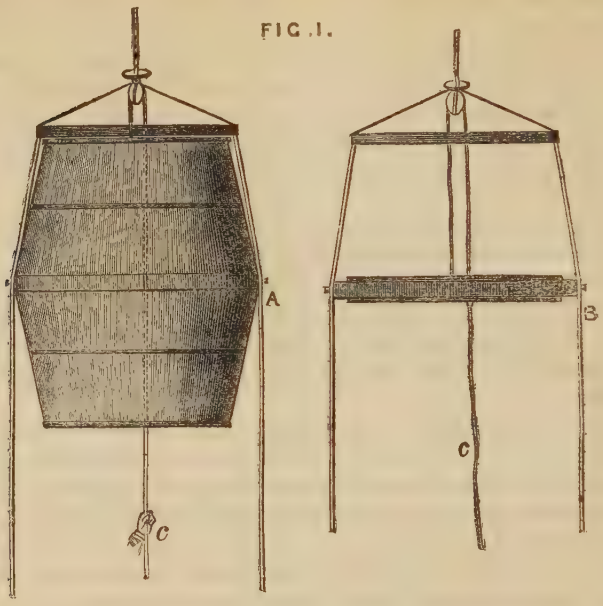
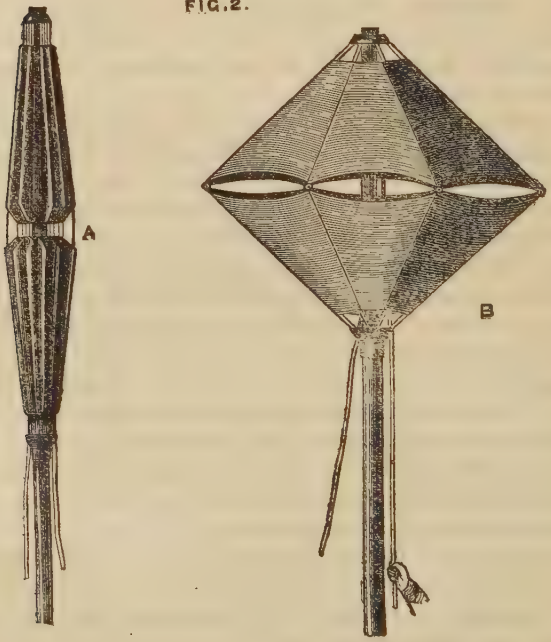
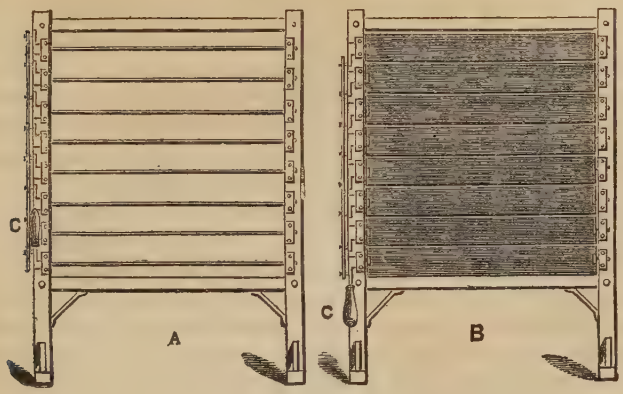



FIG. 2.




COLLAPSING DRUM AND CONES FOR SIGNALS BY DAYLIGHT.

FIG. 3.




SHUTTERS FOR SIGNALS BY DAYLIGHT.

For short distances, when great portability is desirable, a light disc on a short pole with handle can be used. The disc is to be painted white on one side and black on the other, so as to employ either side, according to the nature of the background. The disc turned edge-on to the observer corresponds with an obscuration of the light; the flat side towards the observer meaning an exposure of the light.

Night signal apparatus.

For signalling at night Captain Bolton has produced a portable apparatus, which is effectual for distances up to twenty-five miles. It consists of a lamp provided with a lime-light, and a combination of lenses for directing the rays on any desired point. The light is a modification of that which was many years ago used for trigonometrical observations, in connection with the Ordnance Survey, and known as the Drummond light. There is a moveable disc for displaying and obscuring the light, acted on by a lever, which may be worked by hand or by means of an apparatus devised by Captain Colomb, R.N., called a signal box, and which contains a barrel or cylinder, which is turned by means of the handle. On the surface of the barrel are pins and bars representing several series of flashes, each representing a number or letter. This apparatus is so arranged that the revolution of the barrel causes the pins on its surface to operate on the lamp-shade.

It is, therefore, only necessary to place the keys in slots corresponding to any required set of flashes, and then to turn the handle continuously to produce a revolving series of flashes, corresponding to the setting of the instrument, with unfailing accuracy.

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The apparatus exhibited is adapted to the naval code of signals, but the barrel may be constructed so as to work any code or alphabet. The apparatus can be used by any intelligent man without much training.

Captain Bolton's lime-light being obtained by the ignition of a piece of lime from the heat evolved by the combustion of oxygen and hydrogen gases, requires for its maintenance an apparatus by which the gases will be produced.

He has exhibited this apparatus in a portable form (weight, 1 cwt. 3 qrs., cost 45*l.*). A modification of the lime-light, called the oxy-calcium light, consisting of a spirit lamp, a jet of oxygen, and a pencil of quicklime, is exhibited. In this light the apparatus for producing hydrogen is dispensed with, and the weight is reduced to about 1 cwt., and the cost to 45*l.* The light is effective up to about 12 miles in favourable weather.

Captain Bolton has also proposed and exhibited a lamp in which the light is produced by the combustion of magnesium wire supplied to a focus by means of clockwork. The apparatus, as exhibited, weighs 35 lbs. and costs 20*l.*; the wire is expensive, and the cost of signalling would be about 2*s.* per hour.

It is desirable that a light which is capable of being produced in a more simple way should be devised, and if a satisfactory light be produced it may be expected that the flashing system of signalling will be more extensively applied; it is, therefore, very desirable that the attention of manufacturers should be directed to the subject, with the object of devising a light which shall be powerful, simple, portable, and cheap.

A light produced by the combustion of petroleum has recently been proposed, for which is claimed the foregoing qualities.

An application of the electric light to the purpose would appear desirable; but, as at present produced, the necessary apparatus is wanting in cheapness and portability.

Other military purposes to which signal lamps may be applied.

Lights of the character suitable for distant signalling may be applied to another military purpose, viz., that of illuminating an enemy's works at night. This, heretofore, has been usually effected by means of light balls, viz., oblong projectiles, consisting of a skeleton iron frame, covered with canvas, filled with an inflammable composition, and woolded over what may be distinguished as the cylindrical part with cord or twine, vents being provided at the upper end for the composition to run out of. These balls are projected from a mortar, so as to fall on the spot which it is desired to observe. They give, however, but a

limited sphere of illumination, and are comparatively useless if they roll into hollows in the ground; if they fall into marsh or mud they can be easily approached and smothered. MAJ. LEAHY ON MILITARY TELEGRAPHY.

To remove this objection Colonel Boxer, R.A., devised a very ingenious apparatus, called the parachute light-ball, an example of which is shown in the Royal Laboratory case (British war material). The light is enclosed in a spherical paper case, and is projected from a mortar. It is made to burst, when it has attained its full height, by means of time fuze and a small charge of powder; and the light, which is ignited at the same moment, remains suspended in the air for some time, being kept up, or rather retarded in its descent, by a calico parachute, which is folded up in the paper case, and which opens as the light begins to fall. There is, however, some uncertainty attached to the use of this apparatus. Star shells, *i.e.*, paper shells filled with pellets of a brilliantly burning composition, have been tried successfully, and are likely to be used.

During the American war, lamps with reflectors were used, with the object of discovering working parties. By means of the Drummond light, placed at a distance of 1,000 yards from Fort Sumter, the breach formed in that fort was illuminated, and admitted of an effective artillery fire being kept up, which prevented the Confederates from repairing it.

A lamp, with Drummond light and reflector, by which the ground surrounding an observing station can be illuminated, is exhibited in the Austrian military collection; and an effective apparatus of this description would be of great value during siege operations, both to the defending and attacking forces.

Military electric telegraphs may be considered under two heads. Military electric telegraphs.

First. The lines of communication constructed for temporary use during a campaign and used for conveying orders from the head-quarters of an army to the detached corps, and also for keeping up the communications with the base of operations. This class of telegraph usually consists of two parts, a "field equipment," designed to accompany the army and to lay the wires rapidly, so as to keep up communication between the several bodies of troops during the marches and manœuvres of a campaign; a "reserve equipment," to be used in maintaining the communications with the base of operations, and in repairing and extending the permanent lines in an occupied country.

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Secondly. The permanent lines of telegraph used for connecting works of defence or military posts, and which may be required for notifying intelligence as to an enemy's movements, or with the object of regulating the ranges of artillery, firing torpedoes, &c.

Permanent lines of telegraph have been established in the principal English fortresses.

M. Madsen, the inspector of Government telegraphs in Denmark, has devised a scheme for measuring distances from the maritime defences of Copenhagen by signalling observations taken simultaneously at different forts, and are generally worked by military clerks or other officials, under the supervision of competent instructors. In these lines, portability not being an object, any good and simple description of instrument can be used. They should, however, be of a kind to transmit messages with rapidity; and it is further desirable that the messages should be recorded. Underground wires or air lines may be used, according to local circumstances, the advantage of the former being that they may be more easily concealed and protected from malicious injury.

The "field telegraph" equipment should have a military organization and form a constituent part of an army in the field.

The "reserve" equipment may be organized in time of war by the employment of civilian clerks and workmen, under such regulations and superintendence as the general officer in command may approve.

It is not within the province of this paper to state the relative technical qualities of the different kinds of telegraph instrument, wire, &c., as this will be done by the reporter on Class 64. The following remarks must therefore be understood to have for their object the indication of the points in which the different kinds of apparatus are interesting in regard to their application to military telegraphs.

Austrian field telegraph equipment.

The Austrian Government shows (Gallery No. 6) drawings and examples of the field telegraph equipment adopted in the military service of that country, which are of great interest, as being the only ones of the kind exhibited. The equipment is simple and portable, and is said to answer for laying down the lines of wire rapidly. It is made up as follows:—

1. An office carriage, an example of which is shown, containing the instruments, batteries, &c. The carriage is of the cabriolet form, and conveniently arranged for writing, &c. It is intended to be drawn by two horses.

2. Wire, poles, insulators, &c. which are conveyed in ordinary wagons drawn by four horses. The wire is copper, about No. 16 (Birmingham) guage, and weighs about 70 lbs. per mile. The poles are about 16 ft. long, 2 ins. diameter, slightly tapering, and are carried in the proportion of one for each hundred yards of wire. The poles are shod with iron, and are provided with iron spikes, to which gutta percha insulators can readily be attached. A pole and insulator complete would weigh about 15 lbs.

3. A hand barrow, which is specially arranged to carry a vertical drum for laying out or coiling up the wire. The barrow can be wheeled by one man.

Plain wire is preferred over insulated wire, on account of ts cheapness, lightness, and the facility with which it can be fixed and repaired.

Insulated wires.

Insulated wire, on the other hand, can, if of sufficient strength, be laid on the ground so as not to attract notice; and it does away with the necessity for carrying a large proportion of posts; or light insulated wire may be suspended from posts or attached to trees or houses, and thereby save the transport of insulators.

The cost of insulated wire very much exceeds that of plain wire. The weight varies with the degrees of protection required; but a wire of No. 16 guage can be well insulated at a total weight of 230 lbs. to 300 lbs. per mile.

Insulated wires suitable for military telegraphs are exhibited by Hooper, Siemens (England) Mdme. Bonis, and Rattier et Cie. (France).

Hooper's cable consists of a metallic conductor, insulated, first, by a thin coating of raw india-rubber; then, by a mixture of india-rubber and oxide of zinc; next, by a coating of vulcanized india-rubber, the whole being subjected to a very high temperature. An outer protection of felt, tape, or hemp, tarred, is applied to land lines; and to this is added, for submarine purposes, a protection of iron wires.

Siemens' new cable consists of a metallic conductor, covered with Chatterton's compound, then with a coating of vulcanized india-rubber, and over this plaited hemp painted with whitelead; copper tape is, when required, wound round the cable.

The French cables referred to are insulated by means of gutta percha.

Instruments.

The instruments which may be used with military telegraphs are of the following kinds:—

1. Needle instruments.—2. Dial instruments.—3. Recording instruments.—4. Sounders.

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Needle.

The advantages claimed for needle instruments are that they are cheap, simple, portable, easily repaired, require but feeble currents of electricity, and are easily worked by battery power in a very portable form. It is not, however, always convenient to carry or use batteries. The instruments cannot be worked by an inexperienced person, and they do not leave a record of the message.

Dial.

Dial instruments are frequently worked by magneto-electricity, an important advantage in countries where voltaic batteries are liable to freeze. They are very portable, and can be used by any intelligent person without special training. The disadvantages are the cost, the slowness of communication, the necessity for more perfectly insulated wires when a magnetic current is used, and the absence of any record of the message.

Examples of dial instruments are exhibited by Wheatstone (England), Siemens (England and Prussia), Guillot and Gatchet (France), Marcus (Vienna), and many others.

Marcus, of Vienna, exhibits a dial instrument, with seat and table, so arranged that the whole can be readily carried by a soldier—weight about 35 lbs.

Recording.

Recording instruments suitable for military purposes are shown by Siemens and by Digney Frères, Paris. They are both of the Morse type, but with polarised electro magnets; and with each the message is recorded in ink by dots and dashes on a slip of paper which is gradually unwound by clockwork.

The Austrians also use a Morse recorder with clockwork in a compact form.

Recording instruments possess advantages over others in accuracy and speed, as well as in the more important matter of leaving a record of the message. The greater responsibility which devolves on the operator when messages are recorded tends to care in their transmission, and in military telegraphs this is most important. They can also be used on lines charged either with voltaic electricity or by currents induced from permanent magnets. They require, however, more perfect insulation than the needle instruments, and are not so easily repaired if once out of order.

Siemens' contact plate.

Siemens exhibit a contact plate to be used with their recording instrument, by means of which a person unacquainted with the Morse alphabet can send messages in a perfectly accurate manner by simply passing a steel pin connected with the circuit along grooves in which the contacts necessary to produce the required letters are arranged. The development of this arrangement will very much

simplify the use of recording instruments of the Morse type.

Of the "sounders" exhibited, the most interesting is a small instrument bearing the name of J. D. Caton, Illinois (shown in the American Court, Gallery No. 3), contained in a box measuring about 7 in. in length, 3 in. in width, and ¾ in. high. It is said to be used by guards on railway trains; and by attaching the instrument at any point on a charged line, messages can be received and transmitted, or a message passing through the line can be read. Anecdotes have been told of lines having been tapped during the American war with instruments of this class, so that information was obtained by persons for whom it was least intended.

Siemens exhibit a sounder, which may be worked with feeble currents of electricity, or with badly insulated wires; it is larger than the American instrument.

Sounders may be very useful to officers and others employed to reconnoitre a fortress or enemy's position at night. The person reconnoitering would in this case take with him a small sounder attached to a coil of very light insulated wire, which would be kept constantly charged with electricity from a battery in the trenches or other safe position. By means of the sounder he could transmit information as to his movements or observations to the officer in charge of the covering force.

The disadvantages of sounders are, that they require skilful operators, leave no record of the messages, and can only be used on lines charged by battery power.

## Report on Travelling Articles and Camp Equipage.—(Class 38.)—By Sir S. W. Baker.



The exhibition of this class has been meagre in the extreme from all countries except France, and even the latter country has failed to introduce novelties worthy of consideration in "Travelling Apparatus and Camp Equipage." The articles exhibited by England are very inferior, considering the great scope for inventions afforded by the demands from our colonies and India: nothing absolutely new has been produced.

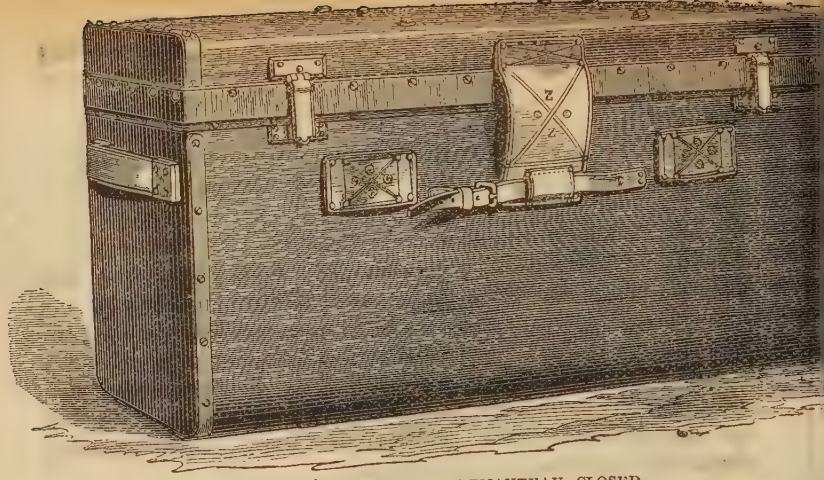
England.

In the English department of this class (38) there are no objects worthy of reward, with the exception of a light waterproof and air-tight portmanteau well adapted for rough travel, manufactured by Wilks, of Cheltenham (*see next page*); this admirable article is reasonable in price, and is in every respect worthy of the silver medal which has been awarded. Ladies' covered baskets by Cave, of Wigmore Street, are the best of their class, and have likewise been awarded the silver medal. The models of tents exhibited were useless as practical illustrations. The good qualities of tents depend upon their being water-tight, portable, and quickly erected; these desiderata could not be proved, neither was there any improvement upon well known forms.

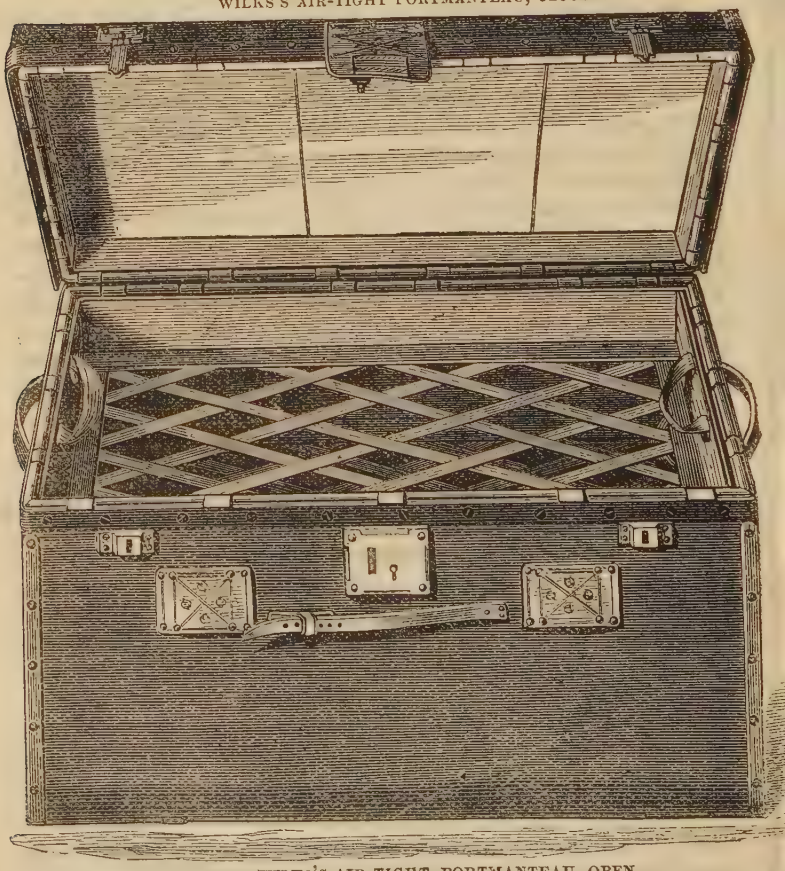
In the French department there were excellent tents displayed by M. Walcker; these were exhibited in the open air in their natural size, and were well tested by the heavy rain. Gold medal.

France.

The general travelling equipment exhibited in the French department was of beautiful workmanship, but of that highly ornamented and expensive kind that is totally unsuitable to rough travel. Of these the most exquisite specimens were manufactured by Dubois and Co. An invention of M. Germain, consisting of a lining of ash veneer instead of millboard, is deserving of notice as a great improvement in portmanteaux that are not of solid leather. Boxes or trunks of light wood covered externally with zinc to render them water-tight and insect-proof were exhibited by Louis Vuitton; these were the only practical examples of equipment adapted to rough work in the French department. In first-rate leather portmanteaux and serviceable travelling-bags without fittings, but simply examples of the best Russian leather and strong workmanship, E. Nessen, of St. Petersburg, was at the head of all exhibitors. The agent of the Russian manufacturer is Eisler, 491, New Oxford Street, London. Silver medal.



WILKS'S AIR-TIGHT PORTMANTEAU, CLOSED.



WILKS'S AIR-TIGHT PORTMANTEAU, OPEN.

The great advantage is the closeness of fitting, secured to the lid by dou
India-rubber tubes. When closed, the portmanteau is not only perfectly
tight and waterproof, but it is also impenetrable to moth, as no insect can en
thus, woollen clothes might be left in perfect security if thoroughly free from
eggs of insects when packed in the case.

REPORT on PRODUCTS OBTAINED by MINING OPERATIONS and the OPERATIONS of METALLURGY.—(Class 40.)—By Professor D. T. ANSTED, M.A., F.R.S., F.G.S., &c. MR. ANSTED ON PRODUCTS OF MINING.

THE objects exhibited in this class are with difficulty dissociated from those in Class 47, described as "mining "plans and processes," and from "geological maps and "sections" in Class 13. They would seem to include also a part of Class 65, described as "materials used in construc- "tions, such as stones of all kinds, slates, cements," &c. I will endeavour, as far as possible, to confine my remarks strictly to the various exhibits referred to the class as constituted, briefly alluding to other classes when the occasion calls for it. Remarks on the classification.

As a general series illustrating mining and metallurgy, the Exhibition, like all former exhibitions, is not only far from perfect, but has many large and important *lacunæ* greatly abstracting from its value for instruction and comparison. Thus, for example, England sends no general collections, hardly any iron ores, very few coals, and scarcely an important object in copper. France is equally without complete collections of ores, though earthy minerals are represented. In other countries, even if there be general collections, the stages of progress between the raw material and the manufacture are imperfectly shown. This is, perhaps, inevitable, and it is evident that the resources of a country cannot be fairly estimated by the figure it makes in the Exhibition. It would have taken much from the value of the class for instruction if the numerous and valuable geological maps and sections that are exhibited could not be examined and referred to while looking at the general collections; but practically this objection does not generally exist, as the maps, &c. are placed with the collections, though referred to other classes. The collections imperfect as a general series.

Notwithstanding its many deficiencies and the absence of completeness, this class is both interesting to those specially concerned and instructive to the general visitor. Some idea of its extent may be obtained from the fact that the whole number of exhibitors exceeds 2,300, and that almost every one of the fifty states and dependencies who have exhibited at all have sent contributions to this class.

The following detailed classification of the class is that suggested by the French commission:— The detailed classification of the French Commissioners.

A. Collections and specimens of rocks, minerals, and ores;

rocks used for ornamental purposes, as marbles and serpentines; hard rocks, as porphyries and granites; refractory minerals; earths and clays for bricks and pottery.

B. Sundry mineral products, as sulphur, salt, bituminous minerals, mineral oils.

C. Combustible minerals, native and coked; artificial fuel.

D. Metals in various stages of preparation; metallic alloys.

E. Products and preparations connected with the precious metals; goldbeaters' work.

F. Products of electro-metallurgy; gilding, silvering, tinning, &c.; results of galvano-plastic art.

G. Products of the working of metals; results of casting, hammering, rolling, &c. of iron, copper, lead, and zinc.

H. Manufactured metals; forged work, wheel tyre, drawn tubes, chains, &c.

I. Manufactures of needles and pins, wire-drawing, metal gauze, and perforated plates.

K. Hardware, edge-tools, ironmongery, coppersmiths' and tinman's work.

Position of the objects.

The exhibits of this class, associated with five others, are for the most part in the elliptic ring called Gallery No. 5. A few of the more striking objects will be found in the outer ring, No. 6, and several also in the park outside the building. There will be little difficulty in discovering them.

In the present report, which is intended chiefly for the English reader, I propose to describe first the British series and the collections from British colonies. The French will come next, and the remaining countries in the order in which they appear in the catalogue.

## I.—Great Britain and British Colonies.

Number of British exhibitors.

Great Britain is represented by 137 exhibitors—a small number compared with some countries; and sending, on the whole, a very imperfect and inadequate series. The principal objects will be easily found and soon examined. Referring to the official classification, we may thus arrange them.

General collections and earthy minerals.

There are but two small general collections of rocks and minerals (50, 56.) Neither of them is extensive. There are one or two exhibitors of Scotch granite (78, 91); there are none of marbles or serpentine. Of clays used for constructive purposes there are several collections. Two are of fire-clays and fire-brick (99, 129), one of them illustrating the well-known Stourbridge mineral. Of pottery-clay, fine

and coarse, there are seven. Among them are some of those that chiefly supply the Staffordshire potteries. The works are, some in Cornwall (23, 80, 121), some in Devon (92, 130), and the others in Dorsetshire (101) and Hampshire (12). The general quality of the clays is well known, and the objects exhibited are fair specimens; but they offer nothing that calls for special remark. They serve to illustrate the nature of the raw material of one of the great industries of England—the manufacture of pottery and porcelain (Class 17), and, though they do this imperfectly, the indications they afford are valuable. All the kaolins or fine porcelain clays are derived from the decomposition of certain varieties of felspar, and generally from granites.

Marbles and serpentines.

Of rocks used for ornamental purposes (marbles, serpentines, and alabasters) there are no British exhibitors in Class 40. The marbles of Derbyshire, Devonshire, and Ireland, and the serpentines of Cornwall and Ireland, find no place, and their proprietors have not attempted to compete with the French, Italian, Portuguese, and other exhibitors.

Of hard rocks (granite, &c.) there is one exhibitor—Macdonald, Field, and Co. (78)—showing some fair work in Scotch granite.

Sundry minerals.

Under the head of sundry minerals may be noticed (98) some fair examples of plumbago (not British) manufactured into excellent crucibles. Salt is entirely absent.

Bituminous minerals.

Of bituminous minerals yielding light-burning (paraffin) oils, and of the oils themselves, there are several specimens. The North Welsh Coal Oil Company (93) and the Welsh Cannel Oil Company both exhibit them. There is a model in Boghead cannel and some of the products of distillation of this remarkable mineral. There are some other similar illustrations, but they by no means do justice to the enormous development of this comparatively new industry in England. The quality of the oils sent cannot be judged of by a mere look at the samples.

Coals, cokes, and artificial fuel.

The series of British coals, cokes, and artificial fuel in the Exhibition is small and imperfect, and affords no clue whatever to the resources of England in regard to this important mineral. No special illustrations are given of the methods of mining, or the geological position of the coal seams; there are few series showing the very different qualities of coal from different districts, and no specimens of several of the most important coal-fields. Of the various exhibits of coal several are Welsh (mostly steam coals), one is Yorkshire, one Lancashire, one Shropshire, and one is a sample of artificial fuel (34).

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There are some large blocks of Welsh coal near the English lighthouse in the park which will, no doubt, show the excellence of their quality before the end of the Exhibition; and these will then compare with advantage with samples at first more showy. There is also an interesting though small series of coals of the Newcastle coal-field (Earl Brandreth's collieries), and the Wigan Company have sent a model and other illustrations of their colliery. There is a fair specimen of the thick coal of Barnsley in the park.

It will not be convenient to follow any further the classification suggested by the French commissioners. The principal metals are generally exhibited separately in the English department, and an idea will be most readily formed of the value and interest of the objects exhibited by adopting the same method in this description.

Indifferent exhibition of iron ores and irons.

Iron.—Of the vast resources of England in iron ores, many of them only recently discovered, there is no attempt at illustration in the Exhibition, although a few samples will be found here and there among manufactured metals. There are only about twelve principal exhibitors of British iron, and though they include some of the best and most celebrated firms, who have all sent goods well calculated to support their high reputation, there is nothing in the magnitude of the objects or novelty of application to render them striking to the general visitor. In these respects North Germany and other countries are much more attractive.

Exhibition of iron in the first state.

The best British exhibits of iron are by the Bowling Iron Company (16), the Low Moor Iron Company (77), the Ystalifera Company (134), and the Earl of Dudley (38). The last exhibits the most interesting group. The irons of all are of the finest quality. Besides these, the West Cumberland Hæmatite Iron Company (128) exhibit fine specimens of their ores (hæmatite), fuel (coke made from Cumberland coal), and different qualities of pig. The kinds of pig used in making Bessemer steel, as supplied to some of the principal manufacturers (Sir John Brown and Co., the Crewe Works, &c.) are placed side by side with the metal used for other purposes.

Of irons that have passed through certain processes, and are exhibited in a marketable state for use, such as large castings, bars of all sizes, rails, and sheet iron for boiler-plate, ship's armour-plate, &c., there are several exhibitors, but, though the quality is good, the results are not showy.

It is only fair to point out that, although many principal

ironmasters and manufacturers connected with the iron trade of Great Britain are either absent or have sent little that is striking, most of the results exhibited in so very remarkable a manner on the French and German sides have been obtained by English methods. Bessemer steel is an example strictly in point, and many others might easily be found. It is certain that English ironmasters have little to gain by any further notoriety, and they have not cared to incur the great expense of forwarding large objects without seeing their way to any corresponding advantage.

There are, however, some cases in which very good results are shown. I will briefly enumerate those to which attention should be directed.

Sir John Brown and Co.—The railway carriage buffers and steel wheel tires are of the very finest quality.

Taylor Brothers and Co.—A cast-steel wheel exhibited by this firm is very remarkable for novelty of construction, as well as excellence of material. It is intended for a steam plough, and its solidity is worth careful observation.

Monk Bridge Company.—All the objects here exhibited are interesting and excellent, and fully sustain the high reputation of the firm. The wheel tires are made without welding, by methods patented by this firm, according to which hammering and rolling are largely replaced by squeezing under hydraulic pressure. The result is in the highest degree satisfactory. Besides the wheel tires, the railway springs and boiler-plate for locomotives should be noticed.

Patent Nut and Bolt Company.—There is nothing in the Exhibition that surpasses the perfection of the work here shown. Material, quality, and sound workmanship are all combined. The bolts range in size from a quarter of an inch to $3\frac{1}{4}$ in. The variety is considerable.

Manufactured iron.

Of manufactures in iron advanced another stage, the delicate and highly finished architectural work of Benham and Sons deserves mention. The patent steel wire mining tackle of Webster and Horsfall is probably the best made, and fully justifies the high reputation of the firm. It deserves notice. There is an admirable and very extensive series of all kinds of ironwork connected with the shoeing of horses exhibited by Dollar Brothers. It may be compared with advantage with the blacksmiths' work of France. The material, style, finish, and careful adaptation to the form of the hoof are all equally remarkable.

Manufactured steel.

Of fine steel work there are not many exhibitors. A silver medal was adjudged to W. Bartleet and Sons for

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needles and fish hooks. The group of objects shown by H. Millward and Sons is also admirable. There are several others very good, but there is nothing very new D. F. Taylor and Co.'s iron and steel wire for toilet pins and other purposes is interesting and good of its kind.

Miscellaneous objects.

B. Baugh exhibits a group of objects enamelled on iron for various household uses. They are exceedingly beautiful, well designed, well executed, and in good taste. They are in some respects novel. Excellent household goods in plain enamelled iron and tinned iron are exhibited by Loveridge.

In this brief enumeration of the most remarkable irons, steels, and iron manufactures referred to Class 40, it can hardly escape notice that Sheffield is very badly represented, and Birmingham and Wolverhampton very imperfectly. It is much to be regretted that this should be the case, and that the English manufacturers of cast steel, hammered iron, and hardware should have declined to take this opportunity of inviting a comparison of which they could not be afraid. I have already alluded to and partly explained the reason of this in speaking of the absence of ores and first products of magnitude and importance such as are found in other parts of the building.

Singularly imperfect exhibition of copper and manufactured copper.

Copper, White and Yellow Metal, and Brass.—Of these important and staple manufactures of England there are but ten exhibitors, and only three of them (4, 33, and 41) exhibit the simple metal. The great smelters have not sent any of their products. There are no large slabs, no bars, no large rolled plates for sheathing or other purposes, and no large hammered vessels. There are, however, several exhibitors of manufactured brass, some of them exhibiting also in the hall of architecture. Bankart and Sons, the English and Australian Copper Company, the Governor and Company of Copper Miners in England, and Elliot's Patent Sheathing and Metal Company, all send small collections of ores and coppers.

Best exhibits of brass.

Among the exhibitors in brass not adapted exclusively for decorative purposes (which hardly belong to the present class), the only one that seems to exhibit any novelty is Jos. Whitley and Co., of Leeds, whose gun metal steam fittings are considered to be of excellent design and workmanship. Their patented valve tap for steam and water has a removable valve and seat, which can be replaced at small cost, whilst the main body of the tap will last for many years. The cast brass inscriptions by the same firm are admirable examples of fine castings.

E. J. Comfort and Co. exhibit fine samples of woven brass wire. Benham and Sons (8), Brown and Downing (22), W. Burgess (24), Hart and Sons (52), W. Keith (70), Lavers and Barraud (72), J. Potter (192), J. W. Singer (109), F. A. Skidmore (110) are exhibitors of ornamental brass. Most of them show very good work, but it is for the most part on a small scale. Brass wire.

Copper utensils are exhibited by D. Baugh (6).

Lead is exhibited fairly, in its various processes, by Mr. Sopwith (113), from Mr. Beaumont's celebrated mines at Alston Moor. The specimens are good and illustrative, but not very striking. Sheet lead is exhibited by Betts and Co. (9), and white lead by S. W. Tudor (122). T. W. Parker and Co. (95) exhibit sundry leads. Exhibits of lead.

Tin is scarcely exhibited as a metal. An amalgam of tin and lead, known under the name of "terne," is exhibited by Morewood and Rogers (89). Exhibits of tin.

Zinc is little seen, as a metal, in the English department. F. Brady and Co., however, exhibit zinc roofing, and some other exhibitors the ordinary manufactures of this metal. Exhibits of zinc.

Nickel and Cobalt are exhibited by Messrs. Evans and Askin in various forms. The same exhibitors send some of their very beautiful and well-known manufactures of German silver in all stages of progress. Exhibits of nickel and cobalt.

It remains now only to speak of the rarer and precious metals. Of these Messrs. Johnson, Matthey, and Co., if not the only, are, at any rate, the most extensive, exhibitors; and nothing in the whole Exhibition can compare with their group of objects, which is equally remarkable for variety, rarity, and (where manufactured) perfection of workmanship. The objects exhibited are— Exhibits of the precious metals by Messrs. Johnson, Matthey, and Co.

1. A fine series of specimens of native gold.

2. Illustrations of Mr. W. Crooke's new method of obtaining gold from admixture with earthy and other minerals by the method of sodium amalgam, by which the most extraordinary results are almost instantaneously produced.

3. An educational series of equal weights and symmetrical forms of a large number of the principal metals, all chemically pure and reduced by fusion. The weights are 1 kilo. (2 lb. $3\frac{1}{4}$ oz. nearly). These specimens illustrate the specific gravity of the metals. The series includes platinum, gold, iridium, palladium, lead, rhodium, silver, bismuth, copper, nickel, cadmium, cobalt, iron, zinc, antimony, thallium, aluminium, magnesium, potassium, and sodium.

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4. Specimens of the following rare metals in various forms:—Palladium, iridium, rhodium, osmium, ruthenium, indium, magnesium, thallium, tellurium, chromium, titanium, and manganese.

5. A magnificent display of platinum apparatus used in the distillation of sulphuric acid. One still, constructed without gold soldering by a method of welding platinum, introduced by the exhibitors, is capable of concentrating eight tons of acid per day; another concentrates five tons. There is also an ingot of pure forged platinum, similar to those out of which the large vessels were hammered. The value of the ingot is 1,100*l.*; the value of the larger of the two stills, 2,500*l.* There are three smaller ingots of platinum smelted by Deville's method of combined gases.*

6. Sundry specimens of manufactured platinum—as tubes, wire, sheet, foil, gauze, sponge, &c., illustrating the various uses of the metal; specimens of platin-iridium, used for certain domestic purposes; platinum tubes, in nests, used for boiling vinegar for pickles.

7. An obelisk of pure magnesium, weighing 5 kilo. (176 oz.), and illustrations of the various forms in which magnesium is brought into the market.

The value of this most remarkable and interesting group of objects is stated by the exhibitors to be about 20,000*l.* It is not easy to say whether the admirable skill and ingenuity shown in the manipulation of platinum or the scientific value and interest of the groups of the other and rarer metals is more to be admired.

## *British Colonies.*

Exhibits from the chief British colonies.

From the British colonies the number of exhibitors is large, and there are several collections of ores, minerals, and rocks of considerable interest. As a whole, however, there is an absence of any very striking effects. Commencing with the North American group, we find from

Canada.

Canada a series of the geological maps and published reports by the Commission Géologique du Canada. The collections of ores of iron, copper, and lead are numerous and varied. The slates and slabs for various purposes are good, and there are good building stones and serpentines. The large polished block of eozoon serpentine is particularly interesting to the geologist, but the colour is not such as

* The visitor should compare these with the soldered platinum retorts exhibited by the French manufacturers. The latter are equally large, but the joints are very inferior. Chapuis, Desmoutes, and Godard are the chief exhibitors.

to recommend it for economic purposes as a marble. Petroleum, as might be expected, abounds, though there is little variety. Steatitic minerals and talc of fine quality has been sent, and there are fair specimens of plumbago. Very beautiful samples of apatite (phosphate of lime) are shown. Manufactured iron is sent, but it has been principally referred to other classes.

Nova Scotia. Nova Scotia has also distinguished itself by a number of general collections of minerals. One of these sent by Dr. Honeyman includes maps and sections illustrating the geology of the country. Among the minerals are several gold nuggets found in the colony in various gold-fields; minerals and products sent by the Acadia Charcoal Iron Company; and several columns of coal. The coal is interesting and well displayed. The curious in such matters will find them near the British lighthouse. One is from the Albion mines, Pictou, which has been noticed in former exhibitions. The seam, as exhibited, measures 11·25 metres (36 ft. 6 in.). The coal is of fair quality. The other seams are less remarkable. There are also from Nova Scotia excellent building stones. As an object of general interest some notice is due to the gold pyramid, a gilt model illustrating how very little a quantity of so valuable a material as gold becomes a great result. The gold represented amounts in value to eight millions of francs, that having been the quantity raised at the close of 1865.

Newfoundland. Newfoundland sends a general series selected by the Geological Survey, and several rich silver-lead and other lead ores, marbles, slates, and bituminous shales, from private exhibitors. Some of these are interesting.

India. India is not well represented in this class. There are several groups of iron ores and irons from various localities, and these form by far the most valuable and interesting part of the collection, but they offer nothing new. There are several exhibitors of corundums, agates, and other ornamental stones; a number of brass utensils of the kind used in the country, and several specimens of saltpetre. There are also some polished jades and porphyries.

South Africa. The Cape of Good Hope has sent rich copper ores of some interest from various localities (chiefly the Cape Copper-Mining Company), and some lignites. Natal has sent coal of fair quality, lead ore, and several varieties of stone and marble.

Australia. From Australia the contributions are various, and appear from several colonies. Queensland sends coal from two

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localities, a large and fine block of pale malachite, and a series of gold nuggets. The Queensland commissioners exhibit in all 161 oz. of gold, and the Bowen committee about $1\frac{1}{4}$ oz. The specimens are fine. South Australia is rich in copper, and sends good and rich, but not very remarkable, specimens from Burra Burra and the other principal localities. These deserve the examination of those interested in copper-mining, but have little general interest. A few specimens of minerals are sent from Victoria. Among them the auriferous earths are the most interesting.

West Indies.

The West Indian Islands are exhibitors to a small extent of mineral products. Barbadoes sends petroleum and bituminous minerals, and St. Vincent, pozzolana.

Graphite (from Madagascar) is exhibited by Mauritius.

Malta.

Malta exhibits the peculiar stones of the island, admirably adapted for sculpture, and several interesting manufactures of iron, copper, and various alloys of copper. The sculptured Maltese stone is not referred to this class.

## France and French Colonies.

Excellence of the French exhibits.

As a whole, the collections exhibited in this class from France and its colonies are not only large but exceedingly good, and, with some exceptions, they afford a fair idea of the resources of the country. They well deserve careful study, and many, both of the raw materials and products, may afford useful suggestions to the English visitor. It would be quite impossible within the limits of this report to enumerate all the separate exhibitors whose goods deserve notice, and I can only pretend to direct attention to the most striking groups.

General collections.

Of general collections and specimens of rocks, minerals, &c., the most important is the series exhibited by the Ministère d'Agriculture, du Commerce, et des Travaux Publics. It is a large and interesting series, including not only minerals and ores, but illustrations of mining operations sent by the engineers of the Imperial Corps des Mines. The specimens are good, and carefully arranged. There is a very fine and interesting collection of the French phosphates of lime, illustrated by a map. Next in importance is a remarkable collection of French iron ores. A large and most interesting series of the earthy carbonates and spathose ores, characteristic of the French iron deposits, and very widely spread elsewhere than in France, well deserves the careful study of English ironmasters and

landed proprietors. Such ores are only now beginning to be estimated at their proper value. Besides this collection, there are other general series on a smaller scale. Among them is one sent by the Marquis de Querrieu (73). The Société Civile des Mines de Maranges, Moselle, exhibit a fine series of the oolitic iron ores of their district. There are no important general series of the ores of other metals. The marbles, serpentines, porphyries, and granites of France are not exhibited in this class. In a polished state they are referred to Classes 14 and 15.

Clays and slates.

Of refractory and plastic clays there are but six exhibitors. One of them exhibits kaolin, from St. Yrieux, near Limoges. The fire-clays, fire-bricks, and crucibles are not remarkable. Of other stoney minerals there are few. Three exhibitors of slates, one of chalk and whiting, and one of casting-sands comprise the whole ; but slates are well shown in another class.

Emerald crystals.

There is in one of the avenues a beautiful group of emerald crystals standing out from a rocky mass. It is from the emerald mines of New Granada (135).

Bituminous minerals.

Among the objects referred to as miscellaneous minerals there is one contributor of sulphur (4), and two of salt (3, 49). Of bituminous minerals there are many examples, some from well-known localities, others from new sources ; and the light burning oils distilled from them or otherwise obtained, are also numerous. The Autun basin (Saône et Loire) is one that has been long known and has yielded large results. The bituminous shales approach the celebrated Boghead mineral, both in appearance and yield. The shales from the departments of Ardéche, Allier, Var, and others, are all interesting, though generally less productive. The results in oil are, on the whole, satisfactory. Of the mineral oils, M. Rondeleux has been most successful in preparation, and is a large exhibitor. A few plans and views are exhibited with these oils.

Asphalte is exhibited from Seyssel (81), and also from Servas (Gard). Bituminous sandstone is sent from Sorgues (Vaucluse).

Turf.

Turf in various forms and products of the distillation of turf are exhibited.

Coals.

Of French coals, which are very numerous and exceedingly varied, the number to be seen in the Exhibition is tolerably large. The united companies of the Loire (344) send a good and complete series of coals, cokes, and products of distillation of coal, plans, sections and models illustrating working. There are also anthracites from

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Laval, Mayenne (17), and Charbonnière, Loire (19); and bituminous coals from Lens (45), Hétind Liétard (47), both in the Pas de Calais, and Auberchicourt (51), in the department du Nord; from Carling (53), in the department of the Moselle, in the east; from the mines of Ahun and Banne, and of the lower Loire, in the middle and centre; and from Rulhe, Aveyron (41), Carmaux, Tarn (42), Graissesac, Herault (44), Cainarade, Ariège (49), and Aups, Var (54), in the south. There are also samples of the coals, and a model of the basin sent by the well-known Creusot Mining Company. From most of the localities there are illustrations of various kinds and samples of the coke. Very interesting illustrations of the coal-mines of Bezenet will also be found. The coals are rarely sufficiently sound to be carried far without injury, and thus great economy in the use of them has become necessary. Bricks of artificial fuel manufactured of the dust of these coals mixed with pitch or tar are extensively used on the railways for the use of locomotives in most parts of France. Besides the products of the mines belonging to the exhibitors, there are also some exhibitors of miscellaneous coals and products obtained from them, France is particularly advanced in the economical uses of slack or small coal, and its position is well indicated in the Exhibition.

Lignites.

Lignites are exhibited from several localities. They offer nothing remarkable.

The Compagnie Générale des Mines de Charbon des Alpes (333), exhibits sections of the coal basin of Dauphin, Basses Alpes. I have alluded above to other illustrations of the same nature, but these do not belong strictly to Class 40.

Iron, raw, wrought, and cast.

Passing on to the metals, we find both a large number of exhibitors and many important exhibits of iron. All the different varieties of wrought and cast iron, Bessemer steel, and cast steel are to be found. The Société Anonyme des Forges d'Audincourt sends a comprehensive series of ores, pig, and manufactured irons, of many kinds. There is nothing new or exceptional, but the whole is thoroughly good. The Soc. An. des Forges et Fonderies de Montataire (145) exhibits good rolled plates; one of them, 36 ft. long and 44 in. wide, weighs about a ton. Besides these, there are several exhibitors of good boiler plate and armour plate and of rolled bars. Among the large exhibitors of admirable works in iron it is right to name Pinart et Cie. (155), of Marquise, near Boulogne, and the Soc. An. des Hauts Fourneaux et Forges d'Anzin (149). The Soc. An. des

Acières d'Imphy St. Seurin (154) exhibits some very fine examples of Bessemer steel, and some of its principal uses; among these are ordnance and projectiles. The whole of this collection deserves careful study, and is very important. There is another group of Bessemer steel, also very good, sent by De Dietrich and Co. (151). An unmanufactured ingot of Bessemer steel, weighing 7,295 kilo. (more than 7 tons), is exhibited by Messrs. Tusey, who are large exhibitors of irons of all kinds. Ingots of cast steel of 25 tons are exhibited with the French guns in a shed in the park. Noble blocks of Sardinian iron ore of the finest quality are also to be found outside this shed. They are worked by a French Company.

Bessemer steel.

Steel.

Among exhibitors of fine iron castings, Durenne (1), and Zegut (2), are worthy of notice both for the quality of their iron, which is very fluid, and the extreme beauty of the objects manufactured. Cristofle's castings (265), are extremely good, and there is a very large series in various parts of the Exhibition.

Fine iron castings.

In copper and copper manufactures France is ahead of every country. So much is this the case that no one can walk through the Exhibition without being struck by the fact; and the more carefully the various details are examined into, the more satisfied will the visitor be with the result.

Copper and manufactured copper.

There are three principal exhibitors close together in the outer or machinery gallery, and therefore apart from the Gallery No. 5, where Class 40 is chiefly exhibited. They are Estivant Frères (320), of Givet (Ardennes); Léstrange et Cie. (329), of Paris; and Laveissière and Son (317), also of Paris. The two latter exhibit other metals. It is very seldom, if ever, that so large and magnificent a group of copper and manufactured copper has been brought together. The objects include native copper, granulated copper, copper slabs weighing 2½ tons, and copper bars (square section), whose sectional area is about 56 in. (7½ in. square), and weight 16 cwt. There are also rolled copper sheets 24 ft. long and 6 ft. wide; drawn copper tubes of unusual diameter and length; enormous copper evaporating pans, hammered from slabs similar to some exhibited, and sheets and tubes of white and yellow metal of unusual dimensions and perfect manufacture.

Besides these objects there are in Gallery No. 5 in the French department numerous exhibitors of copper and brass goods, including steam-taps. Gun-metal and bell-metal, as well as cast bells, are also sent. Of the latter there are many examples.

Copper and brass goods.

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Lead ores and lead.

Lead is well represented in the French department. From the Mines de Meyrueis, Lozère (18), is sent a group of ores, illustrating a magnificent lode of argentiferous galena of unusual interest. One specimen (marked *g* in the series) is a large stone of ore, being the full breadth of a brecciated mass occupying a crevice in limestone, and consisting of angular and rounded fragments of limestone and a pasty cement of argillaceous matter, the whole penetrated by strings of galena. The width of the lode appears to be about 12 in. or 14 in. The lead is very rich in silver. In the same case with the lead are argentiferous copper-ores.

The Pontgibaud Mining Company (13) exhibit noble specimens of their ore and products from the Puy de Dôme country. One fragment of a lode of almost pure galena is about 30 in. long and 18 in. wide. It is said to consist of 62 per cent. of metallic lead, containing at the rate of 135 oz. of silver to the ton of lead. Good specimens of pigs are sent; and there is a button of cupelled silver weighing upwards of 20,000 ozs. (value 5,000*l.*). A fine stone of galena is exhibited by the Société des Mines de l'Argentière, Hautes Alpes (16). This lead is also rich in silver, yielding 140 oz. to the ton of lead. A series of ores and some interesting photographs illustrate the lead-mining of Genna Mari and Ingurtosa, in the island of Sardinia, now worked by a French company. These, therefore, belong more properly to Italy.

Sheet lead and tubing.

A large specimen of sheet lead is exhibited by l'Estrange; one sheet is 70 ft. in length and 9 ft. 6 in. wide; it weighs about three tons. M. Hubin exhibits very fine examples of drawn lead pipe of various dimensions.

Zinc.

Zinc is exhibited by the Vieille Montagne Company (120). The series of manufactured goods is moderately extensive, and the quality good. Ornamental zinc castings are sent by Grados (134) and others. There is a new apparatus exhibited by Michelet, for obtaining metallic zinc by distillation without loss by evaporation. As a general remark with regard to zinc, it may be well to state here that no country has exhibited any new application or any extraordinary illustrations of this metal. The French are as good as any.

Tin (manufactured).

Tin is remarkably well exhibited in the metallic state, especially by Lambert (106), whose sheet-tin series is extremely complete. The sheets ($31\frac{1}{2}$ in. by $21\frac{1}{4}$ in.) weigh from eight to sixty to the kilogramme. The stamped tin is particularly beautiful. The capsules and bottles for

colours are excellent. They are exhibited by more than one firm. Ores of tin are also sent by several exhibitors. Mr. Ansted on Products of Mining.

Gold and platinum are exhibited, but not remarkably. Goldbeaters' work is well shown by Guerin, and the processes of gilding by Favrel. Aluminium is well illustrated by Mourey et Cie. (273), and Morin et Cie. (276). The latter exhibits various manufactures in aluminium and aluminium bronze. They are numerous and beautiful, and include such objects as church ornaments in large proportion. For this they seem well adapted. A splendid nugget of platinum, weighing nearly 210 oz. (6,167 grains), is exhibited with the manufactured platinum retorts of Desmontes and Co. (19). Precious metals. Aluminium bronze.

A considerable number of works of art, some in bronze and aluminium bronze, some reproduced by the galvanoplastic process in various metals, and various metals deposited by electro-plating, are exhibited in the park, near the lighthouses. They occupy a shed constructed for the purpose, and are in the highest degree interesting, both as works of the highest art and finished manufactures exhibiting the greatest ingenuity. They are from Auteuil. These objects for the most part belong to the department of the fine arts, and will no doubt be referred to in another report. So far as they illustrate the mechanical arts of manufacture, and therefore belong to Class 40, they may be pointed out as among the most successful works of the kind hitherto produced. They include many objects of enormous dimensions. Art manufactures in bronze.

## *French Colonies.*

Of the French colonies, Algiers is the principal exhibitor in this as in other classes. There are 33 exhibitors, sending chiefly specimens of ores of copper, lead, iron, mercury, and antimony, and samples of marbles and alabaster. The ores are interesting, and some of them remarkable for their richness of yield ; but, as none of the mines are in actual work on a large scale, they can only be regarded as indications of possible resources. M. Ville (9) has forwarded the most complete series of Algerian minerals. Exhibits from Algeria.

The marbles of Algeria are very varied, and include some of extreme beauty. The well-known and exceedingly beautiful sparry limestone called onyx is shown chiefly in a manufactured state. It is apparently very abundant.

Martinique has sent, among other things, an idol of very considerable size, constructed of a peculiar black, hard granite. It is more curious than beautiful. Exhibits from Martinique and

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Cochin China.

From Cochin China, which appears as French, we have a gun constructed of bell-metal. It is an interesting object both in form and the management of the metal.

## HOLLAND.

Copper and tin manufactures from Holland.

There are but four exhibitors in Class 40, but they include two or three of interest. The castings sent by Enthovan, and the copper goods accompanying them, are admirable. The tins from the East Indies are also a very interesting series. The manufactured tins sent by Andriessens are also worth examination. They consist of drawn tubes, diameter from 2 millem. to 50 millem. (1-20th in. to 2 in.) of pure tin, for sanitary purposes. The price of this tubing is 2f. 66c. per kilo (1*s.* per lb.) It is beautifully made.

Process of diamond cutting.

The very admirable and interesting exhibition of the whole process of diamond cutting, placed in a detached building in the park, appears to belong to Holland, though the diamonds exhibited are almost entirely Brazilian. Probably no such extensive and complete a collection of rough diamonds has ever been brought together. In a large series of trays will be found the cascalhao and other gravel from various localities amongst which the diamonds are found, and the gradual separation of this gravel, leaving behind the rough diamonds. The association of the diamonds with other semi-crystalline forms of carbon, and also with the hydrous varieties of quartz (as cats' eye), is especially noticeable. The groups of crystals of diamond, both complete and in fragments, of all colours and in all degrees of purity, must be seen to be appreciated. The series of illustrations of cleavage is hardly less remarkable. The eye easily recognizes in these specimens the peculiar striation of the diamond, and even those most completely rounded by the action of water are readily recognized by this character alone.

The polished gems (roses and brilliants), and the whole series of processes, are admirably adapted to illustrate the history of the diamond.

## BELGIUM.

General collections exhibited by Belgium very complete.

Class 40 is well represented in the Belgian department by a very large and complete series of the minerals of the country, sent by the "Ministère des Travaux Publics" (58). In this series will be found specimens of ores of iron, lead, and zinc; of coals of various qualities; of marbles, and

other valuable stones; and of several varieties of clay and earthy minerals. The result is very interesting. Many of the marbles, especially the black polished slabs, are of excellent quality, and little inferior to the best Derbyshire. The slates are poor. The specimens of hone-stone are good. The series of galenas and calamines are both fine. The pisolitic ores of iron and the blocks of iron pyrites are very interesting. The latter are said to be unusually rich in sulphur. MR. ANSTED ON PRODUCTS OF MINING.

The series of metals from Belgium is hardly so large or so complete as to justify the reputation of the country. The Belgian ironmasters and coal-owners seem to have followed the example of the English in this respect, and probably for the same reason. In zinc, although the ores are got and the manufacture takes place in Belgium, the companies owning the properties are chiefly foreigners, and thus the best exhibits are not shown here. Of lead also there is comparatively little. Belgian metals and coals imperfectly represented.

## Prussia and North Germany.

The united proprietors of Prussian mines (474 in number) have combined to send to the Paris Exhibition a very large, well selected, and most admirable series of the products of the mineral industries of Prussia. These include a few stones, slates and clays, several salts, some phosphorites and cement stones, a large and varied series of combustible minerals, and an enormous collection of ores. Accompanying this series is an exhibit of maps and statistical tables sent by the Minister of Commerce, Industry, and Public Works at Berlin. There are also models and sections illustrating the working of mines. Besides the general series there are several smaller special collections by particular companies. The general series is so well shown, and so perfectly illustrated by names and localities, that its value would be difficult to overrate. The coals are especially good. They are exhibited in obelisks. One obelisk, built up of blocks of coal of different thickness, represents in each block the quality of the coal, and in the proportionate size of the blocks the output of the coal mining districts to which it refers during the year 1865. The districts are :—Westphalia (9,000,000 tons), Upper Silesia (4,000,000 tons), Saarebruck (3,000,000 tons), Waldenburg (1,250,000 tons), Aix-la-Chapelle, 750,000 tons. There are three very small blocks over Aix-la-Chapelle. Other obelisks show other details. Excellence of the general collections from North Germany. Representative obelisks of coal.

The lignites, much more important in Germany than in England, are also exceedingly well represented. The Lignites.

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miocene (middle tertiary) lignites of Silesia are shown by fragments of trees retaining in all respects their woody texture. The fossils of the German coals and lignites are shown by specimens and by excellent photographs.

Admirable exhibits of lead-mining operations.

Everything connected with the lead mining of the Hartz, of the rich mines of Stolberg, of Clausthal, and of Upper Silesia may here be studied. The ordinary conditions of copper mining and manufacture, as well as the exceptional working of the copper slates of Mansfeld, will be found well explained and illustrated. The zinc ores and the resulting products, as obtained in Silesia by the Vieille Montagne Company, and from other localities, the nickel of Silesia and the Rhine, and the arsenic of Silesia are all illustrated in various processes.

Manufactured irons.

Of manufactured metals the irons exhibited by Krupp are, perhaps, the most remarkable objects in the whole building, and in many respects they are unrivalled. They are accompanied by some specimens of the metal in process of manufacture. Borsig (55) sends a puddle bloom weighing a ton. The Dillingen Company send excellent iron for plates and sheets, with a fine series of hematites. In the Machinery Court are the iron girders exhibited by Horder. They are very fine. One of them measures 25 ft. in length, is 13 in. wide, and $1\frac{1}{2}$ in. thick. It weighs 2,625 kilos. ($2\frac{1}{2}$ tons).

Copper.

Rolled copper is exhibited. The quality seems good, but the objects will hardly bear comparison with those sent by the French manufacturers. Other metals are less important though by no means neglected.

Rock salt.

The rock salt exhibited by the direction of the Royal Mines of Stassfurth is on a large scale and very interesting. The crystals, however, are not so well marked as in some other exhibits. There are several other exhibitors of salt. Wirtemberg, with several manufactured articles of iron and copper, sends a fine block of rock salt. From the Grand Duchy of Baden we have ores of nickel and a group of kitchen utensils enamelled without lead. The most interesting objects from Bavaria are specimens of lithographic stone from Solnhofen, these are very fine.

## Austria.

Miscellaneous series from Austria.

Austria comes next in order. It is well represented in this class by nearly 200 exhibitors. Among the general collections and earthy minerals we find a beautiful stalagmite from the celebrated cavern of Adelsberg—a specimen of nature's manufacture that few countries could rival.

There are also series of earthy minerals of considerable interest, including sulphur, from Galicia and Croatia; graphite from Moravia; sands, ochres, and tripoli from various localities; building stones, lithographic stones, cement stones, slates, and many varieties of marble and porphyry, some of great beauty. There are also magnificent crystals of rock salt, including a polished slab from Galicia and a group of magnificent crystals from the celebrated mines of Wieliczka.

Austrian coals.

The coals of Austria are well represented. The Bohemian and Moravian coals are both shown, and the cokes and artificial coals made from them. There is a curious model of a coal mine also exhibited.

Terra-cotta clay and lignite.

Among the objects exhibited in the park by Austria will be found a series of coals and terra-cottas by H. Drasche. The former includes a collection of the lignites worked by this enterprising manufacturer, who is, perhaps, the largest brickmaker in the world. The series of lignites is interesting, though the qualities are not very good. The annual production from the various mines in Austria, Styria, Moravia, and Hungary, all belonging to this one owner, is 360,000 tons, and upwards of 5,000 hands are employed in the work.

## Switzerland.

Swiss exhibits.

From Switzerland there are 15 exhibitors. They include ores of most of the common and some rarer metals, marbles, and quartz crystals. The marbles, with one exception, are poor.

## Spain and Portugal.

Interesting general series from Spain.

Spain is next in order. There are nearly 200 exhibitors sending many earthy minerals as well as metalliferous ores. The phosphorites from the neighbourhood of Logrosan are interesting. There are sulphurs, salts, and many varieties of marble, graphite, coal, lignite, and asphalte. There are also ores of iron, copper, lead, tin, zinc, mercury, &c. These are mostly placed in a building erected in the park for this purpose. Outside the building are four large and fine blocks of Spanish coal from mines which will some day be much more important than they now are. There is also a fine block of galena. Inside are noble specimens of cinnabar from the well-known mines of Almaden. Besides these, there are very beautiful lead ores from Almeira; and an exquisite geode of sulphur

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from Conil, a locality that yields large quantities of this mineral.

Cuban exhibits.

In the room above the ground floor of this building are plans and specimens from the celebrated Cobre copper-mines of Cuba.

Remarkable series of marbles from Portugal.

Portugal, with fewer exhibitors than Spain, is remarkably prominent, displaying a number of polished marbles of various kinds and much beauty. Many of them are slabs of considerable size; others shafts of columns. Portugal has long been known as possessing very valuable quarries of coloured marbles, but the difficulty of bringing them into the market has been much felt. The specimens now forwarded have been cut and polished with the aid of steam, and the prices at which they can be supplied shows that they are not inaccessible.

## Greece.

Marbles exhibited by Greece.

Greece comes next in order. It exhibits some promising lithographic stones, and some extremely good samples of marbles. The best and largest series is sent by Siegel, of Tinos. Among them a slab of rosso antico is especially to be noticed for its size and quality. There are three shafts of columns, all very beautiful examples of a peculiar veined serpentine, of pale sea-green colour. Greece also exhibits millstones.

## Denmark, Sweden, and Norway.

Denmark sends fine specimens of cryolite from Greenland (used in the manufacture of aluminium). There is also a general collection of minerals of some interest.

Miscellaneous minerals from Sweden.

Sweden is a large contributor. There are a few groups of miscellaneous minerals, including marbles, kaolin, graphite, and lignite. Of these the most interesting is a singular mottled green marble. Among the metalliferous minerals are a few ores of copper, lead, and zinc, some ores of cobalt and nickel, and a large and most interesting series of iron ores and manufactured iron of all kinds and in all states of preparation. The ores are arranged as the base of a pyramid, whose upper part consists of irons made from them.

Iron trophy.

The whole forms a fine trophy. All the irons are of the finest quality. There are several exhibitors of Bessemer steel. There are some interesting geological maps.

Native silvers from Norway.

Norway has 20 exhibitors, but there is little of general interest beyond the specimens of native silver and silver ore from Kongsberg. These are, however, altogether unrivalled, not only in the Exhibition, but in museums. The

snags of native silver are remarkable for their magnitude, the picturesqueness of their forms, and their great variety. The crystals of native silver include a single cube, measuring nearly an inch a side, and a group of crystals, some absolutely perfect, more than a quarter of an inch a side. Laminæ and plates of native silver occupy crevices and fissures in the matrix, and are of extraordinary size and beauty. The various ores of silver are also well and richly exhibited. There is a series of interesting nickel ores.

## RUSSIA.

Manufactures of pietra-dura from Russia.

Russia is a large exhibitor. The Emperor has sent a collection of semi-precious stones found in his dominions, and adapted for the peculiar work in pietra-dura of which finished examples will be found in another class. Of hard porphyries and other hard stones used for ornamental purposes there are several examples. Among them is a block of green jade (nephrite) weighing nearly half a ton. The Demidoff family send from their mines in the government of Perm a block of malachite 2 ft. thick, weighing two tons. There is labradorite and green marble from Finland. M. Alibert (well known for the samples of graphite from Siberia in the London Exhibition of 1865) has not failed to exhibit here also, but the objects are less striking. Among combustible minerals we find several artificial fuels of turf and dung used in Russia. Anthracites are also sent from the river Don, and naphtha from the Caspian Sea.

Russian fuel.

Russian gold and platinum.

Of metalliferous minerals and metals there will be found a fine set of nuggets of gold from Ekaterinburg (92), and auriferous sands from Miask (55) and the Altai (56). Platinum is shown by several exhibitors. Ores of iron, ores of copper, and noble specimens of native copper from Siberia are also to be found. There are some manufactured articles of iron. The manufactured coppers of Russia are numerous and interesting.

## ITALY.

Number and variety of exhibits from Italy.

Italy has not less than 262 exhibitors in this class. In the group of miscellaneous earthy minerals and stones used for economic purposes the variety is very great, and many of the objects are worth careful examination. As a whole the marbles, of which the number is enormous, do not exhibit much novelty, nor are those in the interior of the building large enough to enable the visitor to judge of their

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real value. In the park outside the building there will, however, be found several large blocks of the best qualities of Carrara marble. The largest is a regular and fine block, measuring, apparently, from 60 to 80 cubic feet. All are carefully selected, and do credit to the present state of the quarries. With the rough blocks are many objects manufactured of similar material. These illustrate the quality of the marble when polished.

The Chamber of Commerce of Sienna has sent an interesting group of specimens, accompanied by geological maps, plans, and sections. Kaolin is exhibited from Rome.

Italian sulphur and bitumen.

Sulphur, as might be expected, is largely and well shown, both from Sicily, whence the supplies are very large, and from the eastern slopes of the Apennines, where there are important mines and manufactures. The native and prepared sulphurs offer nothing requiring special notice. Salt is also exhibited. There is an equestrian statue of Garibaldi of this material. It may be doubted whether the features will remain till the end of the Exhibition. Of bituminous shales and bitumen there are one or two remarkable specimens. The most remarkable is from the Pescara valley, where bitumen exists in enormous quantities. The oils obtained by distillation are shown. Natural mineral oils are sent from the neighbourhood of Parma by more than one exhibitor.

Coals and lignites, chiefly the latter, are sent by several exhibitors. Some are of excellent quality. Among them may be mentioned one (112) from near Leghorn (Cecina valley), and an interesting schist from Monte Bolca (122), containing fossil remains of fishes. This deposit is well known to geologists, but it has only recently been utilised.

Elba iron ores.

Of metals and their ores the variety is considerable. The iron ores of Elba are among the best and most easily obtained of any in Europe. Noble specimens of large size and great purity are shown in the French collection.

Monte Catini copper ores.

The copper ores of Monte Catini, in Tuscany, are also very rich and abundant; and the lead ores of the island of Sardinia (exhibited by France) are familiar to every one interested in these metals. We have, besides these, ores of manganese, nickel, cobalt, mercury, and gold.

There are several exhibitors of manufactured iron, copper, and bronze, and some of electro-plate.

## ROUMANIA, TURKEY, AND EGYPT.

Wallachian petroleum.

The Roumanian Principalities exhibit salt on a large scale, sculptured into gigantic busts. The Wallachian

petroleums deserve notice. There are also lignite and anthracite. Mr. Ansted on Products of Mining.

Turkey shows a long list of exhibitors. Among the objects of interest is a peculiar variety of red marble. There are many good building stones of various kinds sent by different exhibitors. There are also samples of soils. It is, however, difficult to point out anything strikingly remarkable in the multitude of small samples that make up the objects sent by nearly 200 contributors. Turkey marble and building stones.

Egypt, like Turkey, sends a number of miscellaneous mineral products. Among the most prominent is a block of salt from the Bitter Lakes. It is about 7 ft. high, and is described as not representing the full thickness of the deposit. The marbles of Egypt are particularly fine; but in the form in which they are exhibited they belong to other classes. Salt from Egypt.

Tunis and Morocco have both sent miscellaneous illustrative collections. They are not without interest, as proving the existence of mineral wealth, but they do not suggest any special remark.

## America.

There are 68 exhibitors in this class from the United States, but there is not much variety. The principal space is occupied by a vast series of ores sufficiently remarkable in themselves, though not requiring so much repetition. They consist of auriferous and argentiferous pyrites. The auriferous pyrites are extremely rich. There are three blocks whose total value is estimated at 1,000*l.*, and two others said to be worth 400*l.* each. The whole collection is valued at half a million of dollars. These extraordinary minerals are from Colorado. Besides this, there is a general series of minerals from other parts of the States. Mineral oil is well exhibited, and many of the samples are of extraordinary transparency and brightness. Auriferous and argentiferous ores from America.

Brazil is chiefly remarkable in Class 40 for the large and important series of diamonds and diamond gravels, already alluded to in speaking of the working of diamonds exhibited by Holland. Besides these there is a small general collection including some fair samples of coal. Brazilian diamond gravel.

Of the South American Republics the most interesting is Chili. The specimens of copper ore are magnificent, and there are also excellent blocks of coal and mineral fuel. Chili copper.

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General remarks.

It is not easy in an exhibition of mineral products, and the first results of manufacture, to discover anything of the nature of progress, or offer comparative remarks in reference to previous exhibitions. This is the more difficult, since the nature of the objects included in the class of mineral products is not in all respects the same as has been the case on former occasions.

That there is much of novelty and interest in the present Exhibition is, however, unquestionable; and to the English visitor the evidence of mineral wealth on a large scale in many districts not hitherto suspected of resources of this kind, will be very suggestive. As the general visitor, except in certain cases where the objects or groups are of unusual dimensions, will, for the most part, be inclined to pass by first products in the excitement and interest attaching to the examination of manufactures of extraordinary beauty, and machinery of extreme ingenuity, perhaps there is the more need of a record such as that now offered.

## Report on Apparatus and Processes of the Art of Mining and of Metallurgy.—(Class 47.)—By Warington W. Smyth, M.A., F.R.S.



The peculiar subdivision and classification of subjects adopted by the French Imperial Commission have introduced into the work of the juries in 1867 sundry anomalies which would have been avoided by a less transcendental system. At our own Exhibitions of 1851 and 1862 the apparatus and the products of the arts of mining and metallurgy were conveniently classed together; whilst on the present occasion the miner and metallurgist found his raw materials and his products (in class 40) entirely cut off from the processes and implements by which he is accustomed to work them, and the two divisions severally grouped with other classes, which in the real conduct of his business have no connexion whatever with his own pursuits. This inconvenience could only be partially remedied by arrangements made by the secretaries of juries to pass certain of the objects exhibited from one class to another. In this manner the geological maps and sections, which ought to be regarded as the records of the exploratory labour upon which the work of the miner is to be based, were placed in the building and by the catalogue, in class 13, along with ordinary geographical maps, but were claimed for consideration by class 40; whilst those which were on a scale detailed enough for being applied directly to the purposes of mining were taken up, along with models of mining localities, into the department of class 47. Similarly, it was agreed between the secretaries that the refractory substances, including plumbago or graphite crucibles, firebricks, &c., several groups of which had been exhibited in our class, should be transferred for the consideration of the jury which dealt with materials of construction in general, and which already had ranged under its numbers a long list of exhibitors of bricks, terra cotta, and refractory materials.

Grouping of objects.

In what belonged properly to class 47 the English portion of the Exhibition was exceedingly meagre; and neither alone, nor taken in conjunction with the display in class 40 (minerals and metals), could it pretend in the remotest degree to represent the greatness and activity of mining and metallurgical life in the United Kingdom. The causes of this deficiency will readily suggest themselves to the minds of those who

Meagreness of English division.

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know our English works, and need, I think, no examination or discussion in these pages. But it is of the highest importance that, whilst our own producers decline so generally, from one cause or another, to enter the lists, we should inquire whether they can properly repose at a distance in fancied security, enwrapped in an atmosphere of self-satisfied superiority, or whether they ought not to be on the *qui vive* and preparing for fresh efforts, on seeing the examples which appear to mark an extraordinary degree of advancement on the part of our foreign competitors.

I propose, therefore, to invite attention chiefly to those objects which are likely to excite the interest of our own masters, overlookers, and workmen, in comparing what we know at home with that which is doing on the Continent.

## Models and Plans of Mining Localities.

Important mining plans of French coal districts.

Some of the most remarkable works of this class are those which illustrate the complicated structure of that important coalfield which extends from the Belgian frontier through the Department du Nord and far into the Pas de Calais. The French Ministry of Public Works has exhibited the map (on a scale of 1 to 25,000) constructed by M. Dormoy, with sections attached to it taken across the breadth of the trough, and showing the position and thickness of the troublesome overlying bed of watery ground called the *torrent*. The map of the Pas de Calais, drawn up by M. Coince, is perhaps still more noticeable as showing on a larger scale (1 to 10,000) the energy and system with which, by means of an elaborate series of borings, all of them accurately recorded, the development of a valuable new coalfield has been accomplished within a very few years. It was only in 1846 that a boring for water at Oignies, not far from Douai, gave evidence of the continuation of the coal measures beneath the cretaceous strata in this direction. The borings of the Escarpelle Company proved, as was pointed out by M. du Souich, that the coal formation was sharply deflected north-westward from its old direction at Valenciennes ; and hence arose, between 1850 and 1864, the establishment of 19 new concessions, 17 of which are in the Pas de Calais, and extend within that department over a length of about 35 miles. Some 40 pits have already been sunk, having, on an average, 100 to 150 metres of overlying formations to pierce, and down to depths of from 180 to 300 metres for their workings.* The amount annually produced from this new and unseen district of coal

New coal fields of the Pas de Calais.

* One pit, that of Ferfey, has its workings at the depth of 460 metres.

has increased steadily from less than 5,000 tons in 1851 to upwards of 1,600,000 tons in 1866.

Plans of a most accurate character, on the scale of 1 to 5,000, have been prepared from the elaborate surveys of M. Grüner to represent the conditions of the still more valuable but old-established coalfield of the Loire, generally known by the name of its chief town, St. Etienne; and a beautiful model, founded upon the maps of the same engineer, has been constructed by M. Leseure, to exhibit the singular curves of the great seam of Rive-de-Gier in the same district. This so-called *grande masse*, varying from 26 feet to above 50 feet in thickness, has been so far explored as to enable all its folds and faults and other accidents to be shown with great minuteness, the small portions which are still uncertain being left blank.

Improvements by legislative measures.

The works thus emanating from the Ministry teach us a useful lesson in connexion with the commercial history of France. Not even the rich and advantageously situated beds of Rive-de-Gier could be worked with profit so long as insufficient capital and a low state of technical knowledge prevailed. The hampering of the coalminers with the claims of surface owners, the undue subdivision of the ground, and the inattention of the Government to the treatment of what was truly a large question, had, between 1832 and 1838, brought the district to the verge of ruin. Most of the collieries were losing money, numbers of them were being successively drowned out, and the prospects of the future were miserably neglected. The present large annual production of over three millions of tons from the basin of the Loire, and the clear light which is now thrown upon the natural conditions of the district, testify to the new life now introduced within the last 17 years by an improved organisation.

Coal field of Alais.

Another representation of the surprising progress made by France within a single generation is exhibited by the mining company of the Grand Combe (6, 19, and 31, France). Few, perhaps, of our countrymen who throng in numbers to Nismes and Avignon are aware that, in those wild and storm-ravaged hills above Alais, the perseverance of the "industriels" has opened out a coalfield which promises to be a most important treasure to the south of France, and is already third on the list of the French coal-districts for its amount of production.* The ravine of the Grand Combe is the locality of the most active mining operations; and a very large model, showing all the plications and disturbances to

* The yearly production of the coal field of the *Gard* is now above 1,200,000 tons.

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which the basin of coal has been subjected, proves, at the same time, the great amount of exploration done within a few years, and the care with which all ascertained data are recorded. Plans, sections, and books of statistics, beautifully kept, are added for the further elucidation of the subject; and one point of especial interest to some of our English coal-workers will be found in the extension, in several places, of the coal-workings far beneath the overlying strata of the Trias.

Belgian coal-field maps and plans.

Several other special localities have been admirably illustrated in the same manner, as the curious seam of coal worked at Creusot (Saône-et-Loire), the mines of the Commentry Company, and the iron-mines of Rancié. But, among them all, none are more worthy of observation than the plans of part of the coal-basin of Liège, executed by M. van Scherpenzeel Thim. By means of exact vertical sections which he has constructed for that field, to the number of 700, he has laid down the precise position of all the seams throughout a slice of the coalfield of 50 metres deep, selected between the horizons of 140 and 190 metres below the level of the sea, as being that portion of the basin which is of the highest present importance in laying out the practical operations. Between these two horizontal planes he determines the position of each bed at every 10 metres of depth; and, by a shading upon a system of conventional perspective, he has given a graphic representation, which, aiding the lines mathematically determined, presents to the eye a distinct picture of the underground relations of this highly contorted but valuable region.

Want of similar works in Great Britain.

These various labours testify to the close exactness of work and to the intelligence of the French and Belgian engineers, as well as to the careful spirit of their respective Governments in dealing with so important an element of national prosperity. How much would the labours of our recently-appointed Royal Commission of Inquiry on Coal have been lightened and rendered satisfactory had similar documents been available in our own coalfields, and had a similar precaution been exercised in registering the results of sinkings and borings, which upon our careless want of system are so often totally lost?

The excellent plans and sections in which the Prussians have recorded their important explorations of Westphalia and Silesia come rather under the head of geological maps, and were reported on at the Exhibition of 1862; but they are not the less worthy of attention from visitors who desire to understand the rapid development of the mineral wealth of these highly valuable districts of coal.

## Working of Mines.

The laying out of the general plan of operations in coal-mines and the methods adopted for the actual getting of the mineral constitute a subject too extensive to be otherwise than partially illustrated in an exhibition. But, considering how such a topic involves the pecuniary economy of obtaining this mainspring of all modern industry as well as the security of the hundreds of thousands of men who toil in what is necessarily a dangerous vocation, we may refer with advantage to a few contributions which tell us somewhat of the processes used in France and Prussia.

Modern importance of coal trade of France and Prussia.

The days are quite past and gone when the coal-workings of these countries were petty and incomplete, and commonly feeble imitations of English originals. The great annual amounts now raised by them—12,000,000 tons by France, and 23,000,000 tons of coal and brown coal together by Prussia—suffice to show that an enormous trade has arisen, and that an experience has been gained both by directors and workmen which has led to much independence of design and process. It has not been without difficulty that so considerable a development has been brought about within so few years, especially in the bringing up of a large population competent to deal with a new task; and in certain districts particularly, as in the department du Gard, the mining companies have had to take in hand all the details of social organisation, as if planting a colony in a desert land.

Getting of thick seams of coal in France.

It may not be generally known that the coalfields of Central and Southern France, although individually of small extent as compared with our own, are remarkable for the occurrence of seams of extraordinary thickness. The tolerably regular beds of coal at Blanzy and Montceau run to 50 ft. and even 60 ft. thick; that of Creusot, where it is raised up into a vertical position, varies from a few feet to 50 ft., 80 ft., and as much as 130 ft, measured right across; and the great seam of Decazeville (Aveyron) often extends to 100 ft. in thickness. Their very magnitude, to say nothing of their often distorted position, entails on the workers a variety of difficulties, which it has taken a great number of years successfully to surmount. One method after another has been tried, and many successive improvements have been introduced, chiefly tending to guard against crush and creep, alike destructive to the getting of coal of fair size and dangerous to the life and limb of the workmen. At last, by common consent, it is allowed that the only full and satisfactory method of getting the largest quantity of coal and of ensuring safety to the men is that of systematic "packing"

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or "stowing" of all their bords, stalls, or gobs—of all excavated places, in fact, except the needful roads—with rubbish (*remblais*), carried down from the surface for that purpose. A night shift of men, the *remblayeurs*, are occupied with this task whilst the colliers are absent from the mine; and in some districts a particular shaft and line of roads and special waggons or tubs are set apart for the work. I am glad to be able to bear witness, from inspection at Montceau and at St. Etienne, how methodically the complete packing is carried out, and how it forms a surprisingly good roof to work under when the next stage below it is attacked. It would be out of place here to enter into the details of the arrangements under which this process is securely followed; but the large block model of the Creusot collieries may be mentioned as showing very fully the curiously irregular position of one of these seams; and the model in the midst of the iron productions of Commentry as illustrating the means of working away the successive horizontal ranges of the thick coalbed of that locality, by the aid of a close packing. A question of this kind can only be fairly judged by reference to the figures obtained from actual experience, which tell of its relative economy. A great expense is undoubtedly incurred; for we believe that, in some pits, as many as one third of the men are engaged as *remblayeurs*. But it would appear that, considering the saving in timber, in round coal, and the comparative immunity from accidents, the French engineers have reason to be satisfied with a system which is the growth of many years of study and practical trial.

Saving of life and general economy.

Higher cost of coal in France than in England.

It is notorious that a chief reason of the inability of the French ironmasters to rival in cheapness their English competitors is the considerably higher price which they have to pay for coal. The reasons for this are manifold. Whether timber propping or stone packing is employed in the pits it is necessarily in much larger proportion than in our more favourably-conditioned English and Welsh coal seams. A French collier, as a general rule, can only get in a day's work from half to four-fifths of what an English hewer will break down. It is only in the pillar-working (*dépilage*) of the thick seams that the French workman obtains an advantage and can get as much as six or seven tons in the day; but for this task he needs a special skill and experience, and earns a much higher wage than the average.*

* The daily wages made by French colliers in the central coal fields are from 3*s.* to 4*s.*, according to the nature of their work.

Owing, again, to the irregularity of the seams, a far larger comparative cost falls to the item of dead-work; and for the same reason the underground transit remains generally on a very inferior footing to that of our first-rate British collieries. Moreover, the total number of people employed about a coal-pit in France has to be exceptionally large for a given output of mineral, in consequence of the general need for carefully cleaning or washing the coal. It is thus only marvellous that, considering how a numerous working population has had to be educated to a peculiar class of labour, the amount of coal raised in France has risen from 1,800,000 tons in 1830, to close upon 12,000,000 tons in 1865. The high civilisation of the country needs, however, a much larger quantity, and the importatious of 1865, chiefly from Belgium, amounted in coal and coke to about 7,100,000 tons besides.

Superior training of colliery officials in France.

Up to the advent of railways our neighbours across the Channel had, in fact, developed their coalfields to a very trifling extent, and their knowledge of the practical art of mining stood at a low point; but since that period the general advancement of trade and manufacture has been kept pace with by the opening of new means of transit, by the association of capital in large companies, and by the constant improvement of the methods and apparatus of working. As far as I have had the opportunity of forming an opinion, the working colliers are generally inferior to our own in working energy, but superior in steadiness; and a great part of the credit for the present active and intelligent conduct of the French coal trade is due to the excellent technical training received by the superior officers and managers at the schools at Paris, and so usefully afforded, in a different degree, to the class from which the sub-officers are taken, by the local mining schools of St. Etienne and Alais.

Prussian thick-coal workings.

The Prussian authorities have exhibited several instructive models, representing their methods of excavating the seams of more moderate thickness in the Sarrebrück coalfield—pillar workings as well as a variety of long wall, some following the level course, others the rise of the strata. Another representation of particular interest shows the removal, in one working, at the Königs Grube, Upper Silesia, of the Sattelflötz, a seam about 24 ft. thick. The bords or stalls are driven 15 ft. wide, with pillars of 20 ft. between them; and the getting of the upper part of the seam is aided by the use of door-frame sets of timber of great height, which must entail heavy expense, unless a large portion of them can be recovered.

Efforts made in France

By no means the least interesting part of the Exhibition,

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in connexion with the daily life of the French colliers, is the indication offered by some of the largest colliery companies of the efforts made to improve the moral and material condition of their workpeople. Anzin, near Valenciennes, exhibits models and a series of plans of colliers' houses built by the company; and Blanzy (Saône-et-Loire) has erected in the grounds a full-sized house, of a pattern largely adopted in that district. Some years ago the French coal-proprietors adopted the plan of building barracks near their pits, in which a number of people could be lodged on a small area; but the pitmen have shown so decided a preference for independent houses, and, if possible, for a bit of garden, that during the last 30 years pit villages of a very superior kind have been formed. It has been a prime object to attach the men to their localities by giving them comfortable cottages at a nominal rent, infant schools and primary schools for their children, and a pension * when incapaciated for work; whilst it has also been sought to remove, as far as possible, the temptation of public houses, which in Belgium and in many places nearer home are a perfect curse to the working collier, and keep him in poverty, notwithstanding his good wages. The outcrop of the coal measures near Blanzy and Montceau is dotted with several colliers villages overlooking a pretty valley. The houses are mostly two and two, surrounded by garden and court, each man having about 160 square yards of ground allotted him. Some of the miners, of a provident disposition, aspire to plots of land and to building houses of their own. The company has, therefore, purchased a tract upon which it grants building lots, and advances money to its workmen for building purposes, charging them no interest as long as they are engaged in the mines. The scheme has been attended by considerable success; and the rising village of Bois-Roulot, if not as regular and as well arranged in some respects as those built by the company, is, at all events, a serviceable means of lodging a tolerably large population, and a testimony to the steadiness of the men.

for comfort of the colliers.

Advances in manufacture of compressed fuels.

Within the last few years careful experiments, conducted by the administration, have proved, what was long doubted, that France possesses coals excellently adapted for sea service; and for some time past no other than French coal has been used in the Imperial navy. But for these purposes the fossil fuels from different localities have to be judiciously

* The Anzin company numbers at present, pensioned workmen, 356; pensioned widows, 455: in all—811; besides assisting 218 orphans.—*Burat Les Houillères de la France*, 1867.

selected and mingled in certain proportions. Taking the coal as a whole, it is noticeable that it makes much more small and dust than our own, and is more frequently apt to be "dirty" or mixed with shale and clay. It hence results that the French coalmasters have been driven to pay a special attention to methods of cleaning their produce and utilising the "slack," *menu*, or small coal. At the Great Exhibition, in 1851 Bérard's coal-washing machine came before us as a novelty, although it was only in certain details that it could rightly be so considered; and, besides several contrivances for that purpose introduced more recently, a great variety of ingenious apparatus has been brought into use for making "patent fuel," *agglomérés*—i.e., for pressing the small coal into cakes of various form by the aid of a small amount of some binding material. These *briquettes* are highly reported upon for naval use; in their carriage to the ports there is a loss of only 1 per cent. against from 6 to 10 per cent. on lump coal; and when stored abroad they are found after two years' exposure scarcely at all injured, whilst ordinary coal would have suffered to the extent of 50 per cent. Moreover, they are very free from ash, and may be made of a mixture of flaming and of dry coal, or of those varieties which have a more free-burning and a more calorific property respectively, in such a ratio as to give the best effect in getting up and maintaining steam. The present Exposition abounds with examples of the machinery and the products of this manufacture; and, although we are not in Great Britain without a similar industry, attention may fairly be called to the subject in the interest of the millions of tons of small coal and of inferior qualities which we are every year actually getting rid of as refuse.

As early as 1833 Messrs. Marsais and Ferrand took out a patent for this purpose, but it was not until 1843 that the agglomerated coal began to be produced in any quantity, and some years more elapsed before the machinery was so far improved by several different engineers as to lead to the present large scale of the manufacture. The St. Etienne Company exhibit a model of their apparatus as employed at Givors, where, by introducing an enormous hydraulic pressure, they need only to add 5½ per cent. of pitch (*brai sec*) to solidify the mass. The stack of rectangular blocks left outside the St. Etienne shed in the "park" throughout the heavy rains of April gave good testimony to the thorough compactness and durability which had been thus attained.

The greater part of the French makers appear to have adopted the circular arrangement of the Messrs. Revollier, and of Mr. Evrard and M. Dehaynin. A beautifully finished

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model is exhibited by the company of La Chazotte (M. Max Evrard, engineer), having 16 cylinders disposed as the radii of a circle, in which the slack, after being heated by a current of steam and mingled by very ingenious apparatus with the pitch, is pressed by pistons and formed either into cylindrical or hexagonal blocks of convenient length. The rate of production appears to be in practice 10 tons per hour with one machine (of which La Chazotte works four), requiring an engine of 50-horse power to work it, and the extreme limit of pressure being 100 atmospheres.

The prices of the St. Etienne compressed fuel are high; the first quality, which contains only 2·10 per cent. of ash, is marked at 28f. per ton; the second, with 5 per cent., at 26f.; whilst the best block coal rules at from 19f. to 23½f., and the small at 9½f. to 15½f. The very small proportion of gas tar or pitchy matter introduced into the mass at this work can scarcely be considered as a general guide, since different qualities of coal will need some more and some less of binding material.

M. Felix Dehaynin, a producer of no less than 175,000 tons of *agglomérés* in the year, exhibits (in class 40) drawings of the Evrard machine as modified by himself and employed at his three works, in which 500 people are engaged. The company called the "Océan," at Paris, are also exhibitors of drawings and of the apparatus for the same purpose known by the name of its inventor, M. Mazeline.

As an adjunct in these operations, an ingenious machine by Hanrez and Co. (Belgium, 12) may be noticed. It is constructed for the drying of small washed coal by the revolution of a screw within a revolving perforated cylinder, and is stated to dry five tons per hour.

Importance of diminishing great waste of small coal at the pits.

We could wish that coalworkers, mineral landowners, and capitalists would note these various indications of what is becoming in France an important trade. Without being unmindful that several companies have been established in South Wales and elsewhere for a similar manufacture, we cannot but be conscious that their action is but an infinitesimal set-off against the wholesale waste of slack that takes place in this country. It is not only that the small coal cut and broken from the saleable part of seams is in most of our districts thrown into goaf and gob by the tens of thousands of tons, but those portions of beds, often some feet in thickness, which are intermixed with stone or "sulphur," or which make a larger than usual proportion of slack, are at once rejected as useless, and acres of such coal are abandoned to be inextricably mixed up with broken roof and heaving floor, although of no worse quality than would be turned to advantage in

many a French colliery. It is impossible in the hard competition of the times to blame individuals for this sin against the economical use of Nature's gifts; but it is a discredit to the country at large, and will, among our descendants, entail many an anathema on the selfish stupidity of their forefathers.

## Boring, Rock-drilling, and Coal-cutting Machines.

All the world has heard of the artesian well of Grenelle; not many among the general public are aware of the striking success of the still deeper well of Passy, and but few are acquainted with the fact that at the present moment two undertakings of the same kind, on the grandest scale, are in course of execution—one in the suburb of the Chapelle, in the extreme north of Paris, by Messrs. Degousée and Laurent; the other at the Butte aux Cailles, in the extreme south of the city, by Messrs. Dru (formerly Mulot and Dru.) These two firms, both noted for a great number of successful borings, exhibit an interesting assortment (57 and 58 France) of the apparatus which they employ for holes of diameters varying from 4 in. up to more than 5 ft.

Success of deep Artesian wells in France.

The experience already acquired in supplying a portion of the French metropolis with excellent water tapped from that great reservoir in the strata of the greensand hundreds of yards below the surface, has led the authorities to contract with thorough confidence for a further supply from the same bountiful source, and to commence the operations on a larger scale than before. In the absence of any great work of the same kind in London, we may remind those interested in hydraulic engineering of some of the chief features of the boreholes already executed*:—Height of surface above the level of the sea at Grenelle, 121·3 ft. English; at Passy, 305·2 ft.; depth of borehole at Grenelle 1800·7 ft.; at Passy, 1923·7 ft.; internal diameter of tube, or lining of hole, at Grenelle, approximately, 9 in. to 6 in. at bottom; at Passy, 2·4 ft. The full diameter of the Passy borehole was 1 metre, or 3·28 ft. English; the new ones are to be, in one case above 5 ft., in the other about 4 ft.; whilst it is proposed to pierce, not only to the water bearing stratum, or *nappe*, already proved to exist, but to a considerably greater depth, in order to cut other feeders which probably abound in the subjacent measures.

Inspection of two borings now in action at Paris.

It is a pleasure to be able to testify to the scientific know-

* *See* Report of M. Cassagnes, Portefeuille Economique des Machines, December 1864.

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ledge and the business-like method which are applied to their task by the conductors of these two interesting operations. Both are alike in some general respects, such as the use of rigid rods only, in preference to rope; the employment of steam to work the rods; and the erection of a lofty pulley-frame, or derrick (*chévre*), in one case 52 ft., in the other 68 ft. high from the ground to the axis of the main pulley. But in the details considerable variations are noticeable. The free-fall cutter, for the use of which these eminent bore-masters are strong advocates, is made to detach itself by a different device, the movement is differently communicated from the steam-cylinder to the walking beam, and there are sundry other variations worthy of study. At the time the British juror and his deputy were courteously met on the spot by Messrs. Dégousée and Laurent the work was unavoidably standing; but various of the implements were put together and lowered and raised to show the facility with which the heavy weights are dealt with. Engineers who only visit the Exhibition, will be able to form some opinion of the nature of the work on seeing the great tower-like tube of riveted iron plates, 1 centimetre thick each, but doubled by close overlapping, which forms a tall, black background to the well arranged group of tools and models in the gallery of machinery.

At Messrs. Dru's borehole the depth, at the end of April, was near upon 500 ft.; the depth cut in the last working day, in chalk and flint, was 94 centimetres. The weight of the boring tool is above 2 tons 18 cwt. The rods are for the most part of wood, with iron connexions; and a length of 20 metres, consisting of two rods of 10 metres each, is raised or lowered at a time.

The magnitude of these operations for artesian wells is greatly exceeded as regards diameter, and therefore weight of apparatus, by the remarkable boring of actual shafts, which has in several cases been successfully completed by Herr Kind. It is matter of notoriety that the sinking of deep pits through difficult ground is, upon the ordinary and even most improved system, a wearisome and expensive task. In the North French coalfield it is estimated by Burat that a capital of 120,000*l.* is expended in the opening of a colliery fitted to raise 100,000 tons per annum, and the examples of Douchy and Aniche were cited, in each of which a still larger proportion of capital has been laid out. A serious part of this cost, amounting roughly to about half, is due to the sinking and fitting of the pits. And we know that, in consequence of the difficulty of piercing through the strata overlying the coal in Durham, sums of 40,000*l.*, 60,000*l.*, and, it is even said,

Great value of results of boring pit shafts.

100,000*l.*, have been expended on a single shaft. We have now, for the future, when so much of our most accessible coal has been exhausted, in a great measure to look to workings further in "the deep" for new supplies, and to shafts sunk through greater depths of Permian and other superjacent formations; and with us, as on the Continent, the problem of sinking with more rapidity and economy is one of the highest moment. We would therefore point to No. 53, France, as well deserving of the gold medal which was awarded by the jury, and of careful attention from colliery viewers. The coal company of St. Avold and L'Hôpital (Moselle) have under that number exhibited diagrams of the results at which they have arrived, and some of the actual apparatus employed in the sinking of pits through a great thickness of watery new red sandstone which overlies the coal measures. The system, we should premise, is not altogether new. Some years ago both Kind and Mulot had undertaken to *bore* shafts of diameters of from 10 ft. to 16 ft., through ground whose "running" nature, like quicksand, prevented the application of the usual modes of pumping out the water and establishing the casing, technically called a tubbing, based on firm and water-tight strata. The excavation was therefore carried on by the borer *à niveau plein*, or with the shaft full of water; and the chief difficulty lay in the jointing, at last, of the iron or wooden lining with the firm ground at the bottom. M. Chaudron, a Belgian engineer, devised for this purpose a sliding piece at the bottom of the tubbing (the whole of which is gradually lowered as the excavation proceeds), on the bottom flange of which, turned outward, is a packing of moss, *boite à mousse*; and, when this latter comes to rest on the seat cut for it by the boring tool, the tower of tubbing, hitherto suspended from above, rests by a corresponding flange on the moss, and so squeezes it together and against the side of the pit as to make a joint tight, after the completion of which the water can be pumped out and the sinking commenced in the common way. Such is the bare outline of the method. Concrete (*béton*) may have to be run in behind the tubbing and many other modifications adopted for insuring a perfect separation between the water in the pit and the world of waters outside.

Their success by the methods of Kind and Chaudron.

Already, in 1860, a signal success was attained by M. Chaudron in sinking an air-shaft at Péronnes, where the watery beds had extended from the 43rd metre to 105 metres deep; and M. de Vaux, Inspector-General under the Belgian Government, reported in 1861 that the work was executed for less than a quarter of what it would have cost under the ordinary method.

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A very ingenious addition of M. Chaudron's is a shield or diaphragm of sheet-iron temporarily fixed near the bottom of the tubbing and having a large pipe or equilibrium-tube in the centre, in which the water can rise, and through which the boring rod passes down, having expanding arms which open out below the shield and excavate the ground. By this means the weight of the tubbing, which at Péronnes was about 88 tons, was so balanced as to throw only about 19 tons upon the vertical iron rods employed for its suspension.

At St. Avold two pits have been thus triumphantly sunk, of which the sections are exhibited. No. 11 pit was sunk through 426 ft. of permeable red sandstone, *grès vosgien;* the final wedging-curb was fixed at 523 ft. deep, on May 1, 1866, and coal was found on April 4 last, at 1,036 ft. The second pit (No. 12) was so far complete that the "moss box" was successfully laid, on February 3 last, at the depth of 521 ft.

The large models of the tubbing and shield, with the gigantic boring-cutters (*trépans*) of above 13 ft. across, will support this slight sketch in calling attention to an innovation which has been attented with a high degree of practical success, and which may hereafter facilitate the developement of untold wealth.

Apparatus for boring blast holes.

Whilst for years past the vertical boring of deep holes, *sondage*, has been aided by the application of steam machinery, numerous inventors in all countries have attempted to solve the problem of applying the same power to supersede hand labour in the miner's daily task of boring holes for firing charges of gunpowder. The common operation, indeed, of drilling by borer and hammer small holes of from 18 in. to 3 ft. deep, by which at present all our hard rocks have to be blasted, is exceedingly laborious, slow, and expensive. Those engineers who have attempted to ignore the value of powder, and to cut the hard stone bodily away, have always failed lamentably. Others have endeavoured to imitate the action of the present hand borers or drills; but the attempts hitherto made in this country to introduce the apparatus into mines have resulted only in delay and disappointment. There are, however, now in the Paris Exhibition two or three inventions which have passed the ordeal of practice, and have actually been employed in the daily service of mines. Since M. Sommeiller's successful application of single borers, each driven from its own cylinder by compressed air acting on a piston, a number of modifications of his general arrangement have been proposed, and it is to some of these that the attention of miners may be specially invited.*

* The reporter deems it but just to add that a recent examination of the Mont Cenis tunnelling operations has strongly impressed on him the merit of

Mr. Doering, of Ruhrort, in Westphalia, mounts his machine on a horizontal arm projecting from a heavy iron carriage, which can be run to and fro on the rails in the level or gallery. The machine itself, consisting of a double-acting cylinder with piston, is, by means of pivoting and the motion of the horizontal arm up and down a vertical standard, capable of being set in any direction and at any height required. The drill, or borer, is attached by a key to the piston rod, and is then by the action of compressed air projected and withdrawn several hundred times a minute against and from the surface of the rock, being turned through a small angle after every blow. A jet of water is constantly squirting into the hole for the removal of the débris, and so forcible and rapid is the action that I have seen above two inches thus bored into a block of hard granite in five minutes The bit, or cutting edge, of the tool may be varied; but the reversed Z shape, thus ⨡, as at Mont Cenis, is preferred, and it is found that it is blunted far less rapidly than when worked by hand with the blow of a mallet. And now for its practical application. One of the jurors, M. Max Braun, director of the great zinc-mines of Moresnet, near Aix-la-Chapelle, under the Vieille Montagne Company, stated to us that eleven of these machines, three of them on the newer construction, have been in actual use there; and that in a level in strong dolomitic rock, where they used to drive by hand labour one metre and a half in 14 days, they have with the machine made an advance of three metres, and sometimes even four metres in the same time, and with only two men instead of six. The advantage, therefore, in the economy of the great standard expense of mining work is so obvious as to require no comment.

Successful application of boring machines at Moresnet,

Another machine meriting attention for the same reasons is the "Bergborr maskin" of M. Bergström, exhibited by the mine of Persberg, in Sweden. The stand for it is a strong bar, with steeled point at the bottom, and steeled holders regulated by a screw at the top; and as the boring cylinder traverses up and down the bar, this latter must be fixed by the aid of cross timber, in a direction parallel to that of the intended borehole. The drill is then made to act by compressed air in a manner generally similar to the last, although there are considerable differences in the construction. The weight of the whole apparatus is only 120 lbs., and it may

and at Persberg.

the original invention of Sommeiller's perforators, and of the skill by which so high a degree of practical success has been attained. The advancement of the Modane end, in moderately hard schistose rock with veins of quartz, was at the time of his visit when ten machine borers were working upwards of two metres or 6 ft. 6 in. per diem.—W.W.S. May 1868.

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thus easily be moved from place to place, although open to the objection of giving more trouble in fixing. The very machine which is exhibited is stated to have worked for 700 days underground, and to have bored 1,000 metres. When tried upon hard granite it has bored two metres in the hour; and, as in Doering's machine, the "bit" has been found to last five times longer than when struck by hand.

A third modification of this general type is the machine exhibited by General Haupt, an American. It is mounted between two upright bars, which are fixed between floor and roof, and thus does not admit of the same scope of direction as Doering's. The movement of the piston and drill is effected by steam; but whilst the jury were making their inspection it never could be brought into steady action. The valve arrangements are particularly ingenious, and the moderate size and weight of the apparatus are in its favour. A highly laudatory pamphlet accompanies this "perforator" to Europe, but does not contain any distinct statement of the machine having been actually employed in mining operations.

It should be stated in fairness to others who have not exhibited that all the above machines are variations upon the type of that which was brought forward by Karl Schumann, of Freiberg, in Saxony, in 1856.

Drilling rock by aid of diamond.

A very beautiful horizontal cylinder-engine is exhibited by M. De la Roche Tolay, engineer of the Chemin de Fer du Midi, intended to bore the rock by a rapidly rotating drill forced forward by hydraulic pressure of about 1,540 lbs. Various forms of cutting drill have been experimented on, but the only one which appears to have given good results in hard rock is the diamond-mounted ring of M. Leschot. And, however preposterous it may sound to apply the valuable gem to the boring of holes in granite and quartz rock, visitors to the Exhibition may see it actually perform its work with considerable rapidity, and observe from a large drawing on the wall near it how it is proposed to arrange several of these machines at once for attacking a tunnel face. The boring implement is tubular, and admits a jet of water through the middle into the hole; its face, of soft iron, is studded with eight pieces of black diamond, carefully hammered up; and the incomparable hardness of the adamant encounters with such success the hardest materials of common rock that the engineer states the cost of the abrasion of diamond for a hole of half a metre deep to be under twopence. Very many experiments have been made at surface, but it is not asserted that the machine has been subjected to practical trial underground.

Machine proposed for tunnelling.

The tunnelling machine, by Captains Beaumont and Locock, R.E., impelled by compressed air and looking a *monstrum*

*horrendum ingens*, has already attracted much attention from visitors to the gallery of British machinery. It is a heavy, powerful means of projecting against the face of the rock a disc armed at its circumference with 36 borers, which, gradually turning with the disc, cut an annular groove, whilst a central borer at the same time drills a hole of equal depth, which is afterwards to be charged with powder and fired. Whatever engineers may think of it for abbreviating the labour of tunnelling, it is too cumbrous, and, for various reasons, inapplicable for ordinary mining.

Machine for cutting out blocks of marble.

There is yet another machine to be mentioned which has done good service in economising labour and in preventing waste in the marble quarries of Rutland County, Vermont, U.S. It is the invention of Mr. Wardwell, and is exhibited in full size in the outer shed of the United States department by the Steam Stone-cutter Company, of New York. The machine, propelled by a small steam-engine of four-horse power, consists of a carriage of 5 feet in width, carrying on both sides a series of vertical bars armed with cutters which notch out a groove of the required depth instead of its being cut by the picks of the quarrymen. It is asserted that in these extensive quarries, where many hundreds of men used to be employed, the action of this machine in reducing the labour cost and saving the marble by the narrowness and greater accuracy of the cut has been eminently satisfactory.

## Coal-cutting Machines.

Substitution of machines for manual labour in cutting coal.

Of far greater importance to this country are the attempts which for several years have been made to replace by machinery the labour of holing, kirving, or undercutting the seams of coal. The purely mechanical operation of cutting, by means of a light pick, a groove of from 2½ feet to 4 feet deep along the face of coal which is to be removed is not only slow and laborious, but wasteful, as cutting into slack a considerable amount of the seam; and, forming as it does the chief item of expense in the excavation of the coal, it has of late been more seriously forced upon the attention of coal-owners by the irregularity and strikes of the workmen, which have so often brought the operations of the coal-mines to a ruinous standstill.

The earliest of these machines which may be pronounced a success is the pick machine of Messrs. Firth and Donisthorpe, worked by compressed air. I had the advantage of seeing it doing excellent work by way of trial in 1863, at Hetton; and I am informed by Mr. Lindsay Wood, now managing that great colliery, that two of them have been daily at work

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for upwards of four years, and that they have given entire satisfaction. More of them would have been employed but for the difficulties which arise in practice of adapting to them a special mode of work which shall also suit the particular character of the roof. Two newer machines are exhibited at Paris which deserve special notice. Messrs. Jones and Levick, of Blaina (Great Britain, 8) have constructed a very portable carriage, movable along rails by a hand-wheel, and mounting a pick at any required height in the seam, so carried in a revolving head-stock that, instead of only striking horizontally, as in most of the earlier inventions, it may be applied to any angle of inclination in which the seam lies. A pressure of 30 lbs. to 37 lbs. to the inch is applied through flexible tubes, and from 60 to 70 blows per minute are given, with a result, when all is in order, of undercutting to the depth of 3 ft. or 3½ ft. along a length of 9 yards to 15 yards in an hour. This would appear, on the face of it, to be a substitution for a great number of men; but other important advantages are gained. A better proportion of large coal is obtained; and, the holeing groove being very much less high in the front than where the hand-pick is employed, a comparatively small quantity of coal is cut into slack.

Pick machines.

Slotting machines for cutting coal.

These latter advantages are shared by the machine of Messrs. Carrett, Marshall, and Co., of Leeds (Great Britain, 3), a more complicated apparatus, the chief feature of which is a strong steel bar, armed with three cutters or scoops, and forced by hydraulic pressure against the coal in such wise as to form the undercut by a sort of planing action oblique to the face. Instead of passing three times along the front of the coal, as do the pick-machines, in order to cut inward to the required depth, this contrivance completes the full depth at once, and without percussive action, or making dust and noise; it moreover cuts through iron pyrites and band-stone with facility. Mr. J. Liddell, of Newcastle, has kindly informed me that he has had one at work occasionally, and experimentally, for 12 months; that, when in full order, it has cut as much as 12 yards in an hour; but that, from circumstances in the seam of coal, the mode of working, &c., he is not yet in a position to give definite results to as the economy of its use.

It is unnecessary to dwell at length on the various ingenious arrangements which have been applied to these machines, but we may point with satisfaction to the inventions of our countrymen which are likely to aid in maintaining our position as the first producers of cheap coal; and the importance of the subject is further shown by the liberal offer of the colliery proprietors of South Lancashire and Cheshire

to give prizes of 500*l.*, 200*l.*, and 100*l.*, for the first, second, and third best coal-cutting machines which shall have been fairly tested by their committee, in trials to commence in November next.



## Coal-pit Fittings.

Pit-head framing of France and Belgium.

Whilst our British producers of mineral deemed it not worth their while, for the sake of a medal and a small modicum of glory, to incur the trouble and expense of sending over to Paris the familiar forms of apparatus which they employ, a number of French and Belgian coalowners have forwarded models and full-sized fittings, which, if they have nothing specially new about them, yet play an important part in showing the present position of the mechanical arrangements brought to bear on their mines. Thus, the Company of Béthune (Pas de Calais) exhibits, in its full size, a stout pit-head frame, with flat-rope pulleys, wooden guides, cages, and tipping arrangements, all of them very similar to examples which we may find at home. The colliery is an interesting one, as being founded on that portion of the northern coal-field which has been so skilfully explored beneath its complete covering of the chalk formation, and being advanced to within a moderate distance of the Channel. Here, as in most of the recent establishments, the apparatus is on a good scale, and calculated to serve the purpose of working an extensive area from one set of pits. The Blanzy Company (Saône et Loire) represent in model another form of wooden frame, housed in, with a neat belfry-like roofing even over the sheaves or pulleys. A more novel construction is represented among the excellent collection of the collieries of the Loire (St. Etienne, &c.), placed in a special building in the park. The leg-beams, stays, and shedding are all of wrought-iron, as erected at the pit of St. Louis in 1864. A different system, that of building the main beams as cylinders of sheet-iron, rivited together, had in 1862 been adopted at the pit Jabin, and after four years of work stands perfectly well. The magnificent pit-head frames of the Forster pit, at Seaton Delaval, are known among us as a good example of wrought-iron applied to this purpose, but the economy of the use of the metal as compared with wood is not yet fully proved. The French fittings in wrought-iron have been tried, on the observation of the engineers that, in their district, six years are sufficient to render unserviceable the common head-stocks of pine; whilst ten years bring even oak to such a condition as to require expensive repairs. Pit ropes are exhibited of various forms and material. The

Frames in wrought iron.

Similarity to British arrangements.

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heavy flat ropes of aloe-fibre are much employed in the north of France and in Belgium, where some of the shafts are of greater depth than any in our own country.

In the better collieries of both the above countries cages of a construction similar to those of our northern pits are very generally employed for the conveyance of the tubs or waggons up and down the shaft. Many of these are exhibited in full size, some of them two-decked, to carry two tubs or waggons on one floor; others for narrow shafts, having four tiers or decks for one tub each.

Cages for pits.

M. Libotte (Belgium 16) shows cages for six tubs—one with two tiers of three tubs each; the other of very awkward length, of six decks. The former weighed when constructed, as usual, of rolled iron, 3,960 lbs.; the latter 4,180 lbs. Simultaneously with what is doing in some of our Durham and Northumbrian mines, this engineer has been substituting steel for iron in order to reduce the dead weight, and thus brings his new steel cages for the carriage of the same amount of coal to the more moderate weights of 2,200 lbs. and 2,640 lbs. respectively.

Safety clutches for pits.

Ever since the Great Exhibition of 1851 numerous inventors have turned their attention to the subject of providing the cages with safety catches, intended to grip the guides in case of the breakage of the rope. In 1855 and 1862 a long list of contrivances had to be reported upon; but, even up to the present day, the opinions of those most conversant with pit machinery are divided on the question of which of them, if any, is preferable to simply doing without them, if only due caution be exercised in employing the very best material and frequently overhauling the rope. It is matter for regret that none of our English inventors appear this time in the field, since Calow, Owen, White and Grant, Aytoun, and others, have devised various ingenious modes of attaining this important object, and many of our English pits have been thus fitted for years past. There was nothing new to see on the present occasion. One of the oldest, and theoretically perhaps a rather objectionable form, that of Fontaine, is still shown as in use at the great Anzin collieries, and merits respect from the number of lives it has actually saved. Jacquet, of Arras, and others, exhibit a clutch acting by a toothed excentric, similarly to that of White and Grant; and M. Nyst, of Belgium, his system of applying a pair of iron forks to trapezoidal wooden guides M. Krauss, of Prussia, also exhibits what appears to be a good modification. Where the speed of winding is moderate, as in many of the continental and of our central and southern collieries, several of these varieties may do good service; but

where the great velocity of Lancashire and the north is in vogue the tendency of the clutches to come into play during the rapid descent is very troublesome and even dangerous.

Among safety lamps for fiery collieries several of the known modifications of the Davy are exhibited, and among them sundry contrivances for more effectually locking them than by the common method. A new one is that of M. Arnould, of Mons, who so inserts an iron pin that the lamp can only be unlocked by placing it in a proper position over the poles of a powerful magnet, and thus puts it out of the power of the men to expose the flame. Unfortunately however, as we have too sadly seen in some of our late colliery accidents, all these precautions may be rendered utterly futile by the determination of colliers to carry lucifer matches in their pockets for the ready getting a light, when, against all rules and all prudence, they choose to strike it.

Safety lamps.

For the ventilation of mines nothing new has been proposed since 1862. But there are placed along with the fittings of the French collieries models of fine examples of the ventilators of Fabry, of Lemielle, and Guibal, the last two of which are now introduced with success into some of our English coal districts.

## Dressing, or Mechanical Preparation of Ores.

A variety of apparatus in this department is exhibited little of which is characterised by novelty. The company of Fives-Lille (France, 55 and 87), whose engineers are Messrs. Huet and Geyler, make a considerable display in the gallery of machinery, of circular revolving tables, jigging hutches, &c., of iron, not without merit, and of some novelty to France, but following very closely the models of a well-known Prussian manufacturing house at Deutz, near Cologne.

The Austrian mining administration of Przibram and Schemnitz have sent drawings and models of a number of useful inventions for the dressing of silver-lead and of gold ores. Most of them are the production of Mr. P. von Rittinger, whose able services in this direction have gained him a European reputation; and they have been already shown and commented upon at former exhibitions. Our mining agents and engineers may, however, study with advantage the models which tell of his efforts to obtain continuous, instead of interrupted, action, especially in his jigging machine, and in the side-action percussion frame or shaking table. Of the latter contrivance two examples have been recently erected at the mines of the Vigra and Clogau Mining Company, North Wales, where they act admirably in separating the metallic

Rittinger's inventions for dressing ores.

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sulphides, which occur along with the gold in their St. David's lode.

Amid the sad collapse and pressure which have for the last year or two weighed so heavily on our British copper and tin mines, simply in consequence of the large amounts of the ores of those metals which have been cheaply raised in distant countries, it is to be regretted that neither in this department nor any other of the actual processes of mining is our insular industry represented.

## Apparatus employed in Metallurgy.

New forms of furnaces.

Omitting to notice several models of blast furnaces, which offer no important feature of novelty, I should remark that the exhibitors from several different countries show that more attention is being bestowed on the economy of heat and on the utilisation of inferior fuels, by the introduction of gas-furnaces and of apparatus of the class of the regenerator of Messrs. Siemens. Some of the more interesting of these were contributed by Sweden, especially the elaborate model of M. Lundin, showing the method by which he obtains the inflammable gases from wet sawdust (which in vast quantity has hitherto in that country been a waste product), frees it from watery vapour, and then applies it to a steel furnace, to brick-kilns, or other purposes. Lundin's arrangement would be applicable to the burning of such materials as wet peat, inferior coals, and lignites, which are of very little or no value when tried on common fire-bars.

Good arrangements in French ironworks.

Among the extensive collections exhibited by Schneider and Co., of Creusot, in a special building in the park, some large drawings are well worthy of observation which illustrate the excellent arrangement of the enormous mills and forges and machine-making departments of that establishment. Some of the jury of our class indeed concluded (and it was the only subject on which we had a considerable divergence of opinion) that the distinguished Vice-President of the Chamber of Representatives ought to receive a *grand prix* for the success which had attended his efforts to produce from materials of only moderate quality manufactures of great excellence; and they held that the judicious arrangement of the various groups and divisions of the work contributed in no small degree to the economy of his finished products. And it certainly was no light argument to point to the building, out in that remote south-eastern portion of France, of a whole army of locomotives for a British railway!

Fine examples of rolled iron.

The French ironmasters have for years past enjoyed a reputation for the rolling of good qualities and particular forms of iron. In 1855 the capital iron girders which were

being abundantly employed in the erection of common street houses aroused the interest of many of our jurors; and now, in 1867, the works of Chatillon and Commentry, and of Petin, Gaudet, and Co. distinguish themselves by the finest examples of rolled girders and plates that have been seen. To understand, in fact, how some of these beams of one metre high and with very broad flanges at top and bottom had been so well and evenly rolled, it was necessary to see the model exhibited by the former company (France, 88), showing on a small scale the complex arrangements of their universal mill, *laminoir universel*. Messrs. Marel Frères, the well-known makers of many kinds of machinery, exhibit a rolling-mill of the same elaborate character. It is placed near the boring apparatus of Dégousée and Laurent. M. Wagner, the director of the works of Mariazell, in Styria (Austria 5), also furnishes, although on a much smaller scale than the last, the model of a rolling-mill for the same purpose, as devised by himself. No doubt many of the products turned out by these machines, and shown in the Champ de Mars, may fairly be considered *tours de force*, but we cannot withhold from the French iron producers the credit of having attained by their skill and perseverance to a high grade of excellence.

### Steam-engines for Winding and Pumping.

If there were any one department of machinery in which we Englishmen used to think, a few years ago, that we had it all our own way, it was the construction of steam engines. And although it might be conceded that taste was to be found across the Channel, and that good designs might be produced, and perhaps, even light work executed by French and Belgian engineers, still it was confidently asserted that, for heavy work and for powerful engines, they must come to England. A glance at the Paris Exhibition will dispel these illusions, and teach us that machine makers and designers have arisen who have made good use of a sound education in mechanics, and who are competent to cope with the tasks daily brought before them by the progress of engineering.

Large steam engines exhibited by French and Belgian makers.

Several large winding-machines for collieries are brought before us in full size, and exhibit the types which are now attached to some of the first-class works. Thus, M. Quillacq has erected an engine with two coupled vertical cylinders in front of the pit-frame of the Bethune Company, the piston rods acting directly on the shaft of the drum or rope-roll. Belgium has sent two double cylinder engines, each, like the last, of about 200-horse power. Both these, that exhibited by the Chatelineaux Company, and that of MM. Dorzée and Andry (Belgium, 19 and 6), have their cylinders mounted

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on a pyramidal iron framing, and working downwards upon the rope-drum, which is placed at the level of the ground. Something may be gained by this mode of construction in the economy of the engine-house, but several reasons might be adduced in favour of the opposite system, generally followed at our large collieries, of planting the cylinders low and mounting the drum above. These engines, as also the well-finished, powerful, horizontal machine exhibited by the Creusot Company, are fitted with a special cylinder for a steam brake, and sometimes with an apparatus for arresting, independently of the engineman, the progress of the cage on its going dangerously high in case of inattention. One of these contrivances, a long horizontal screw, along which a carriage travels as the cage ascends, was already exhibited in 1862 by the maker, M. Gouteaux, of Gilly.

Successful competition of foreign engine builders with our

Some modifications of pumping-engines, which evince much ingenuity, are exhibited in drawing by M. Colson (Belgium 5), but their merits can scarcely be pronounced upon without observation of their effectiveness in practice. The French engine maker, M. Quillacq, of Anzin (Nord), not only exhibits his productions in drawings and actual engines, but excited the incredulity of some of the jury by a statement that he had supplied both pumping and winding steam-engines to an important Newcastle colliery. That such a Gallic invasion of our great centre of colliery operations should have taken place without some special reasons or private arrangement appeared highly improbable, and I at once communicated with the owner for the purpose of obtaining the explanation. It is but justice to the French engineer to state that the order for the direct action pumping-engine which he supplied was given simply in consequence of his lower price and better finish as compared with the tenders from English houses. It has now been at work above 18 months, and I quote the particulars kindly sent me by the owner in saying that "it has given the greatest satisfaction," and that "the construction and the quality of material and workmanship are very good." This has led to the order of a pair of winding engines for the same place, which are also "highly satisfactory." Here we have, then, one of our Newcastle mines actually working by means of French-made machinery, fairly brought in by open competition to the midst of our machine shops and founderies; and when we look at the inland position of Anzin, and the unquestionable disadvantages which have to be combated in a district where coal and iron are comparatively dear, I cannot but think these results redound to the credit of French engineering and inculcate on ourselves an important lesson.

## Report on Prime Movers, Boilers, and Engines specially adapted to the Requirements of the Exhibition.—(Class 52.)—By J. Scott Russell, Esq., M.A., F.R.S.



Scope of the report.

This Report is not intended to form either an inventory of the objects exhibited in this Department or to express an opinion on the relative merits of exhibitors. I propose to confine myself to the duty of selecting, from among all the objects exhibited in my department, those only which illustrate some important principle, which may serve for the advancement of practical engineering in the future, or indicate some progress in the past. I hope thus to avoid all interference with the duties of the jurors, whose business it was to measure the relative merit of exhibitors, and of the commissioners, whose duty it was to award prizes proportioned to those merits. My aim, in the performance of this duty, is to extract as much good as I can from the study of the works of different nations in this Exhibition, in order to serve my countrymen, for their instruction, emulation, and successful competition for the future.

The first question which I asked myself in entering on the study of my department was this—Are there exhibited here works of any nation which ought to be regarded as discoveries or inventions tending to give a new direction or a fresh impulse to the creation of machinery for the development of power?—are there any new species of steam-engine, air-engine, fire-engine, or water-engine capable of developing or directing the forces of nature, so as to act as prime movers to modern machinery?—any which either tend to increase human power, or to develop it more effectually and economically, to transmit it further and more rapidly and to apply it to its purpose more directly and immediately than heretofore?

Progress in the construction of steam-engines.

In the construction of steam-engines, I am happy to be able to report some progress, holding out the promise of important future development. America, England, and France each produce examples of steam-engines, in which the refinements of modern science have been applied in a most judicious manner, so as to give out the utmost power due to a given amount of steam and to effect its economical application to practical use.

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There is also exhibited a remarkable method for the transmission of the force of falling water from the place of its fall to the place of its application, to drive distant machinery, which has already yielded social results of practical importance by means astonishingly simple, which have been slowly and unostentatiously matured.

Besides these larger developments and striking instances of additions to human power shown in the present exhibition, there are to be discovered more widely spread throughout the engines of different nations marks of gentle, uniform, but certain progress. This progress consists, not in the discovery or application of new principles, but in the steady increase of the application of known science to the amelioration and refinement of the ordinary machinery employed in commercial duty. Nowhere does the education of a nation in technical science display itself more unmistakably than in the refinement or in the coarseness of the methods by which it attempts to extract out of the living forces of nature all that is in them of motive power; and in this Exhibition the differences between an educated and an uneducated nation is truly remarkable.

Importance of instruction in technical science.

When I say scientific refinements in the development of power, such as an educated people achieve and an uneducated one neglects, I may appear to many to attach undue importance to what may appear rather the elegancies and luxuries of machinery; but a little consideration will set this right. Conceive two countries, one technically ignorant, the other technically refined. Conceive that in the former fuel costs 25 per cent more than in the other; it is plain that in the same market the manufacturer of one country could have no chance of competing with the manufacturer in the other. But we also know that the refinements of modern science can so spare the consumption of fuel, and can so utilise the power of that economised fuel, that one engine shall be able to perform exactly the same duty as another engine on exactly one half the consumption of fuel. What James Watt did for us was little more than the application of his early instruction in the science of heat to the economisation of fuel in the steam-engine; and now, if a nation wealthy in fuel chooses to waste it from want of skill and refinement in the engines which turn it to use, that nation throws away all the advantages of nature, and yields to another nation which, with greater skill in its steam-engines, in their owners and their users, is able to do the same work by using a less value of dearer coal.

illustrated by economy in consumption of fuel.

It will therefore not be unimportant to watch the degrees in which the nations who have dear and scarce fuel have

armed themselves with the weapons of science to wage the war of competition with those who waste their wealth of fuel; and it is by a multitude of comparatively small refinements, carefully appreciated and habitually practised, rather than by any achievement of discovery, that this is carried out. A little economy in the construction of a furnace grate; a little wiser application of air to fuel; a little more scientific proportion of one part of a boiler to another part; a somewhat more complete utilisation of the entire substance of a boiler as heating surface; a little better condition of steam on leaving the boiler and entering the engine; some smaller loss of steam by radiation and condensation; some smaller waste of steam in passages, valves, and vacant spaces; a little sharper opening and shutting of valves; a little more delicate regulation of the admission of steam in proportion to the power required; some more perfect lubrication of joints; more delicate precautions for the exquisite truth of bearing surfaces; greater refinement in the mechanism to correct the inevitable wear and tear of work; precautions for the absence of vibration, and the neutralisation of unbalanced strain. These are all refinements—small, perhaps, individually, yet in the aggregate so great that the man whose skill achieves them all maintains his superiority over the man who, wasting his fuel in mere brute force on coarsely planned machinery, throws away all the advantages conferred by nature, by his inability to understand, appreciate, or use the scientific refinements of modern engineering art.

This Exhibition is full of examples of such refinements, and the study of them, as carried out by different nations in different ways, may serve to teach us this lesson, that, if we will hoard our wealth of coal, and cease to despise the technical knowledge, the refinements of science, and the delicate contrivances of engineering art, we may substitute brains and knowledge for waste and extravagance, and, by using our own fuel as wisely as those less favoured nations, we shall retain our supremacy in that which they do not possess, by rivalling the skill which has husbanded their resources and corrected their inequality.

## Steam-engines.

Steam-engines. England.

Possibly the most remarkable steam-engine in the Exhibition is one exhibited in the English Department, but which is the joint production of two Americans and one English firm. Should this engine be as successful as it now promises to become, it will mark the commencement of a new era in English manufacturing machinery. Already it possesses most

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of the refinements of which we have been speaking; but it aims at something much more important, and beyond all these. This engine is intended to do the work of four times the ordinary engine of the same size, and it does it. An engine of 100-horse power nominally is able to do the work of 200 real horses; but this engine of the same size will do the work of 800 horses.

This, then, we take as a remarkable engine; and it would be unquestionably entitled to call itself the most remarkable engine in the Exhibition if a sufficiently long experience of its use in daily work had enabled us to feel satisfied that daily, and from day to day, it could continue to do as ordinary drudgery the extraordinary feats which now as *tours de force* it is able to perform. But the mere challenge and endeavour in a little engine to utilise so much steam-power is sufficiently important to arrest attention and justify our careful study. Every part of it has been matter of profound study; and when we know that it is manufactured by Whitworth, of Manchester, we know that it contains all the conditions of durability, truth, and strength, for which his productions have long been famed.

France.

A second very remarkable engine is that produced by the Admiralty of France, and constructed under the direction and from the plans of the chief constructor of the navy, M. Dupuy de Lome. There is no engine of similar construction to this either in the navy of another country, or in its ordinary manufacturing machinery. It is a three-cylinder engine, and the plan of three cylinders driving three cranks has long been known as one of the best methods of securing uniform mechanical power from the application of steam-cylinders to produce revolving motion. The special peculiarity of this kind of engine is the way in which it utilises and economises the steam. The three cylinders are of different sorts, applied to different purposes. The first, or central, engine is a high-pressure engine; the second and third, which lie on each side of it, are low-pressure or condensing engines; yet they are all three alike in size, appearance, general arrangement, and proportion, and all three do nearly identical work. The work which they now do in the Exhibition is merely the pumping of water out of the Seine into a lake, and serves to show the engine without testing its quality. But its inventor, M. Dupuy de Lome, claims for it not only superior economy of fuel, but superior quality of work, superior endurance, and perfect reliability in the work of war. This, therefore, is an engine which challenges our attention, which deserves and requires very careful study, and which is far more ingenious and valuable

than its seeming simplicity and unchallenging aspect would lead us to suppose.

America.

A third remarkable engine is American, both in invention and execution, and forms, perhaps, the most remarkable feature of the American department. It exhibits thoughtful design, ingenious contrivance, refined skill, and admirable execution. It is singularly unlike an English engine. It has four ports on four different parts of the cylinder, two on one side and two on the opposite side, each worked by a separate mechanism. These ports are worked by valves, not sliding, like our own, on flat surfaces, but sliding valves on cylindrical surfaces. Close up to the cylinder these valves cut off the steam with scarce a particle of waste room, and so economise to the utmost the high-pressure steam which they admit, and which they use as expansively and as sparingly as possible. The mechanism by which these valves are moved is to our eye outlandish and extraordinary; but it is, in truth, refined, elegant, most effectual, and judicious; it spares steam to the utmost, but develops what it uses to most effect. Then it proportions in an admirable way the doses of steam it serves out to the continually varying quantity of work the engine has to do. The mechanism of its mechanical governor is wonderfully delicate and direct; the governor is sensitive to the most delicate changes of speed, and feels the slightest demand made upon the engine for more or less work and steady speed. A mechanism as beautiful as the human hand releases or retains its grasp of the feeding valve, and gives a greater or less dose of steam in nice proportion to each varying want. The American engine of Corliss everywhere tells of wise forethought, judicious proportion, sound execution, and exquisite contrivance.

These are the three salient engines of the three nations most distinguished for the prime movers they have sent to this Exhibition; but they are by no means the only engines which mark progress, which exhibit merit, or which deserve careful study. Many other engines are worthy of all praise as examples of conscientious execution, scientific design, and excellent performance. These have no doubt been rewarded by the approbation of the employers whom they serve, and the award of the juries who have had to decide on their relative degrees of merit. Many of them are so excellent, indeed, that I have thought it my duty in the body of this report to describe them as examples of sound engineering construction, although they did not possess that startling novelty which arrests our attention, and appears to challenge us to future emulation, and open up the way to new achievements.

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## Of Transmission of Water Power and other Prime Movers.

M. Hirn's invention of the telodynamic transmitter.

It will now be necessary to say a few words to justify the selection I have made of the telodynamic transmitter of mechanical power, invented by M. Hirn, as a discovery or invention possessing high virtue as an engine for the future development of the mechanical resources of power for manufacturing nations. Who can have stood beside the Falls of Niagara, of the Rhine, or of the Clyde, without feeling awed by an overwhelming sense of the development of enormous power in the descent of these huge masses of water, continually pouring night and day millions of tons through millions of feet? What engineer could stand by these millions of horse-power wasted and not feel the irresistible longing to turn this wasted power into sources of useful work? Unhappily, the situation of such a waterfall is not a matter of choice; it is there, and ordinarily not in a place convenient or capable of serving as the home of an industrious manufacturing community. It is impossible not to feel the wish to transport this waterfall into the midst of the adjacent town to give life and motion to its mills and manufactories, so as to supersede its smoke and economise its fuel by the simple weight of falling water. M. Hirn has proposed to himself this simple problem: "How shall I take "the power of the water away to a distance from the waterfall "without having the trouble of taking here also the water "itself?" The solution he attained is remarkable, equally for its fascinating simplicity and its philosophical depth. "I "cannot carry the matter of the waterfall, but I will carry its "spirit." The essence of its power, the spirit of the waterfall, is *speed*. "I will carry speed, velocity, force, from the "waterfall; but I will not carry water, matter, weight, or, if "I do, I will carry as little as I can of dead matter, and as "much as I can of living speed." This is what he sought to do—how to transport speed.

This transport of power to great distances at small expense, both of capital and current cost, is what I have ventured to consider as a discovery or invention of no common importance in the future economy of nations. A river rushes down a broad valley; villages and towns dot the valley and fringe the mountains; there is an industrious population which can only develope its manufacturing industry by the aid of foreign far-fetched supplies of fuel. M. Hirn leaves the villages where they are, but spreads out on each side of the river from river bank to mountain foot—one, two, three, or five miles on each hand—the long lines of his telodynamic communication. On the river itself he erects his water-

wheels or prime movers, and there extracts from the water its moving force. He uses, to embody that force, a small mass of steel or iron, not more than a finger's thickness, or about the diameter of a musket-ball: this steel cord he shoots along with a velocity of 100 ft. in a second, or 6,000 ft. a minute. Flying with this speed of 30 or 60 miles an hour, this dynamic messenger carries its deposit of power and delivers it out at the end of a journey of a few miles with only a moderate per-centage of loss on the way. How small this loss it must have required the most sanguine of inventors to believe; indeed, at starting it was anything but small; his early transmitter of speed flew to pieces in the act of transmission, his steel rope wore out long before it had paid for its cost, and his wheels eat themselves to pieces faster than their work would pay for duty done. M. Hirn had everything to invent, and it was years before he taught his egg to stand on end merely by the gentle crack of Columbus. The Columbus egg, to him, was the discovery of gutta-percha, and how he employed it to transmit speed by steel without waste may be told here in a few words.

The mechanism by which M. Hirn accomplishes this transfer is so simple and, after it has been described, so obviously effectual that a few words put us in possession of the entire system and method. Given a waterfall of 100-horse power and a town five miles away, an ordinary water-wheel is erected at the fall to receive its power, and the ordinary machinery of the factory to be driven is erected in the town. On a framing some height above the ground is erected a simple iron wheel or pulley, 12 ft. in diameter, with a groove in its circumference. A similar framing, with a similar wheel, is erected at the factory in the town. A wire or steel rope not thicker than one's finger traverses the whole distance along pulleys, some 6 ft. in diameter, placed 150 yards apart, and this simple rope transfers through the whole five miles the whole force of the water-wheel at the fall with the loss of some 20-horse power only in the transmission. Here, it will be said, is no invention. Nevertheless, the process, as I have now described it, would not be successful. So small a rope could not transfer 100-horse power, neither would the ropes nor the pulleys last; it has neither economy nor endurance. To make the arrangement successful, we must add M. Hirn's idea of speed—of extremely high speed. Instead of driving his pulleys at an ordinary pace, he makes the rope travel 20, 30, 50 miles an hour; and it is this speed alone which enables so slender a cord to transmit so enormous a power. When he had made this discovery his invention failed, for no materials would endure at this high speed either

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for his rope or his wheels; iron, steel, copper, brass, bronze, leather, wood—all were tried and failed. At last he discovered a simple expedient: all round his pulleys he cuts a deep dovetailed groove into which he hammers, till it is filled, a hard compact mass of gutta-percha, and in the gutta-percha he leaves a groove. This done, his invention is complete, effectual, durable, economical. It has lasted seven years in this state and has been successfully applied in some 400 instances.

## Boilers.

The boilers of steam-engines appear to afford much less scope for the exercise of invention or discovery than the engines themselves which convert the forces of the steam into motive power; perhaps it is that the law of transference of heat out of fuel into water is better understood, or, possibly it is more a question concerning the chemical forces of nature than the mechanical arrangements of invention. Nevertheless, it is undoubted that between the fire and the chimney much heat is generally wasted, and it is also true that our newspapers are continually recording terrible accidents arising from the explosion of boilers.

I find it difficult to say that from this Exhibition we learn much regarding boilers that can be called new, or that there are any striking displays of old known principles applied in a more useful manner than heretofore known and practised. Perhaps the least known expedient is one which seems to receive great favour in France. It is a way of taking out the inside of a boiler, cleaning it, and putting it in again, Two French engineers, Farcot and Thomas, seem to be independent authors of plans for doing this. It is well known that the formation of mineral deposits and concretions inside a boiler is a frequent cause of explosion, and is the source of continual loss of heat during its formation, as well as of rapid decay. In general, also, it is the inside of the boiler furnaces and flues which are most subject to this action. These gentlemen conceived and executed plans by which the internal parts of a boiler are united together in a convenient mass which, at one point, is separable from the external skin; the joint is unbolted, the inside withdrawn, both thoroughly cleaned, rejoined, and rebolted, and this within a moderate number of hours, so that it can be done monthly or quarterly. To do this they adopt a cylindrical exterior of moderate dimension; they use the brass tubes of a locomotive or marine boiler so grouped in one with the furnace that the interior being withdrawn in one mass the cylinder is left empty and accessible. In addition to these improvements

France.

Methods of cleaning the insides of boilers.

M. Farcot has chosen to separate the generating part of his boiler from what we may call the receiving or accumulating part, for he communicates all the heat to the water in a lower cylinder, the interior of which comes out as I have mentioned, but he accumulates all the intensely heated water and steam in a second cylinder lying above it, and communicating with it only by a few large apertures. This enables him to limit the diameter of his cylinders, which he considers as a measure of safety. He next incloses both cylinders within hot-air flues from his furnace, either by a brick or an iron envelope going round the whole outer surface of his boiler. He conceives that he has thus solved the problem of a boiler without waste, for he has converted every portion even of the outer skin into effective heating surface; he has given his boiler safety by limiting the diameter of his cylinders, and he has made it durable and economical, first, by the removable inside; and, second, by the large extent of moderately-heated surface which he allows for a given nominal horse power. Messrs. Laurens et Thomas also withdraw the interior tubes and furnace of boilers, only group them differently.

Cylindrical tubular boiler without joints.

In the mechanical structure of boilers there is also in the French department one remarkable phenomenon. There is a cylindrical tubular boiler without a single joint—one entire piece of hammered iron, so admirably executed as to be the most singular piece of ironwork in boilers we have ever seen. It has been the habit in this country of some eminent engineers to get rid of some of the joints of cylindrical boilers by welding, but to make an entire boiler all in one piece, without a single joint, including also the ends, has not yet, I think, been considered worth the pains; yet it is certain that joints in boilers are places which cause both danger and decay.

Utilisation of waste steam.

There is one application of boilers which, if not a boiler itself, is an important application of steam to economic use. A high-pressure engine may usually be seen puffing off all the steam which has given it motion into the air as waste; this is, indeed, so much waste heat; and a Prussian engineer, Aders, economises this heat by causing it to boil the contents of two sugar-boilers. The manner in which he first applies in one the direct force of the waste steam to evaporate syrup of a given strength, and then employs the steam raised by that to give off its last store of heat to another, is curious, interesting, and profitable.

## Engines specially adapted to the Requirements of the Exhibition.

This title may be taken to include not only steam-engines and boilers where they are used to drive the machinery of

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the Exhibition, and to do work for it, but also the pumps, blowers, and other mechanism by which water is supplied and air fed into the building. The arrangements, however, for ventilation were not ready during the early part of the Exhibition, and judgment will be best taken on them after their powers have been tried by the hot and dry weather of summer. There are, also, a multitude of small steam-cranes, which in nearly every department of the works of the Exhibition were well calculated to render important service in the transport of heavy loads of machinery to be erected.

Steam cranes.

England.

These most countries seem to have adopted in some measure; but they are most numerous in the English department, probably because in England they were first introduced to save expensive labour by means of cheap fuel. The best of them can raise a large weight from the ground, turn it round a complete circle in the air, carry it by steam along rails, and lay it down at any indicated place at the end of the journey; they may, in short, be called universal steam handing machines, and they differ mainly from each other in the greater or less convenience, simplicity, or accessibility of their mechanism. Many of them are by firms who have great reputation in England for their construction. It was at one time intended that their respective merits should have been determined by a competitive performance, but as this was given up I cannot say which did its work best. One of them is a curiosity in mechanics, and to the eye it is the simplest and most compact of them all; it has neither piston, piston-rod, nor crank, and would seem merely a common hand crane but for the bolier, but the barrel of the crane is made to revolve by a direct rotatory engine; and if the competitive trial had come off we might have been able to ascertain by precise measures whether the simplicity of this engine is or is not compensated by some mechanical defect.

Boiler-houses and chimneys.

Perhaps also we should notice that handsome boiler-houses and chimneys have been erected in the grounds by many architects competing in the variety of decorated boiler-houses and picturesque chimneys. After all, cleanliness and inoffensiveness are probably the best qualities of a boiler-house, and a chimney must always remain a smoke-stack, even when covered with decoration. There is but one beauty possible in a chimney, the symmetry of a graceful outline. Unluckily, this is the rarest quality of architecture, especially of chimney architecture. There is in the whole Exhibition but one example of a beautiful form for a steam-engine chimney, and that building is, unluckily, not a chimney, but a lighthouse. To men about to build chimney-stacks we would therefore say: don't copy the exhibited

chimney-stacks, but study the beauty of form of the French lighthouse, and take into your mind the principle of construction which governs that form, then go and do likewise. The lighthouse is a structure of iron, not brick; but *mutatis mutandis* it is a type of slender aspiring symmetry, and makes an admirable model for smoke-stacks.

Boiler-house in British section.

One of the most suitable boiler-houses is naturally the offspring of the Brompton boilers. A handsome decorated boiler-house has been very simply and not expensively constructed on the terra-cotta pillars of the late Godfrey Sykes, of the Kensington Museum.

When the other machinery of the Exhibition is in full work there may be something more to notice in the mechanism of the pumps and fans which supply the two fluid elements.

## Great Britain.

Great Britain inadequately represented.

The prime movers of Great Britain are represented in the Exhibition by a large marine steam-engine of 350-horse power, sent there by the Admiralty, and by a few smaller engines, which drive machinery in the building. It cannot be said that in quantity the steam-engines of Great Britain are adequately represented. Most of the large houses have sent no steam-engines; others have sent small ones; some, models; but, on the whole, it is impossible to say that the prime movers of the machinery of England are adequately represented in Paris. As we have said, it was the Admiralty which sent Mr. Penn's engine as a pendant to the French Admiralty which sent M. Dupuy de Lome's; and it is right to add that it was the energy of the management of the English department which caused the majority of the steam-engines there to be sent over. What British reluctance means is a very important question. Were we afraid; were we incompetent; were we merely reluctant; or had the British merchant settled that the transaction was not profitable? It is important that these questions should be answered somehow, and one of the objects of such a report as this is to select suitable data for a true answer both as to the cause and the consequences of our inadequate appearance at this Exhibition. If exhibitions be to us a losing game, the sooner that is acknowledged the better. Perhaps it is only that we think the transactions of a great exhibition more profitable to the exhibitors of the country and to the inhabitants of the capital that gives it, than to the strangers who exhibit there. If that be true, it seems to say that there must soon be an end of International Exhibitions. Or, if it should be true that in machinery we are aware that we

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have made no progress and have nothing new to show, while other people have made great progress, and want to show it, that would be a still more important conclusion to recognise if true, because it would lead us to make serious efforts to examine our deficiences, and set to work as a nation at once to make them good, and take care that at the next exhibition we should distance all our competitors.

Mr. Penn's engine.

With this view let us analyse what we have sent. Mr. Penn's engine is a pattern of good execution and exact workmanship. The general design of the engine is that which the English Admiralty has long adopted as their standard marine-engine. It has Penn's horizontal trunk cylinders; it has his usual slide-valves, worked by eccentrics and a link motion; it has a very simple expansive valve and gear, worked also by an eccentric, variable at will, by an elegant and simple piece of mechanism. It is characterised by all the elegant simplicities which have rendered Penn's engine classic in the Navy—all about it roomy, convenient, and come-at-able. But this particular engine has something beyond that. Mr. Penn has had the courage to introduce into it the modern improvement of dry condensing, an invention which must in the end be the characteristic of all good marine-engines, but which has been so long under way without complete success that all who touch it must do so with extreme caution; and I fear I must say that our eminent colleague Mr. Humphrys died of it. Mr. Penn has approached dry condensing with due caution. One can see at once from the look of the engine that he is afraid of it. The apparatus for circulating the cold water is no part of the mechanism of the engine, but is a pair of separate steam-engines, driving a pair of Appold's centrifugal pumps; and arrangements are jealously made, so that if the dry condenser proves treacherous, our old friend the cold water jet shall once more resume its old place in the condenser and prevent further mischief. One cannot help feeling in looking at this engine that it is a favourable example both of British caution and British progress in the marine steam-engine. We shall have to compare it, when we come to consider the engines of France, with the machinery of the Imperial factory at Indret, with that of the great engine factory at La Seyne, and with that made at Creusot.

Development of power by initial speed of piston.

The next engine we select from the prime movers of England is the one we have already referred to as the result of the invention and ability of two Americans and one Englishman, and its performance as well as its purpose is truly remarkable. It is the intention of this engine, as I have before said, to perform four times the work of an ordi-

nary engine of the same size. The means by which it proposes to accomplish this is by a principle which will become more and more developed in the future progress of engineering, but which has been hitherto more recognised elsewhere than in England. Marine screw-engines are perhaps, by forethought, somewhat advanced in this direction, and locomotive engines partake of the principle. The principle is this—*the development of power by initial speed of piston.* This principle deserves specific attention.

Speed is a remarkable quality of steam as a prime mover of which we have not as yet comprehended the value, and therefore very inadequately made use. We are continually making steam go slow in our prime movers even when the purpose of the engines is to communicate high speed, and not slow; and we then proceed to turn our slow speed into a quick one by means of tooth-wheeled and other clumsy mechanism of all kinds. Engineers of the future will hardly believe that English engineers should so long have bowed their necks under the law that the pistons of cylinders should only travel the slow pace of 200 ft. a minute. This pace is some 3 ft. a second, or about two miles an hour; and what could have induced us to tie down a steam horse power to the pace of two miles an hour it is not easy to conceive, except that that is about the pace of a horse labouring in a gin or tugging a canal boat, and doing most work within the eight hours of its labouring day. Now, the efficiency of steam has nothing to do with a pace so absurdly slow. Steam will follow a piston with great ease 1,000 ft. a minute or even 10,000 ft. a minute, with as perfect efficiency as 200 ft., and what relation 200 ft. a minute can have to the nature of steam it is impossible to imagine. We marine engineers have long rejected this respectable tradition, and now this engine comes to throw off the yoke altogether and reject the antiquated dogma for the stationary engines of manufacturing trade.

The Allen Whitworth porter engine.

The Allen Whitworth Porter engine starts off at a piston speed of 800 ft. per minute, being four times the normal speed. The effect of the engine is startling. Some of its reciprocating parts move faster than the eye can follow. It calls itself 50-horse power; but they are all racehorses, and they each do the work of four ordinary horses. Whatever work a common engine of a given size at the common pace will do, this engine of the same size will do four times as much, because, with equal force, it will cover four times the space. Of course, it is needless to say that with such a change as this everything else in the engine has to be changed also; and it is in these changes—their judgment, their value, and their adequacy—that the great merits of this engine consist.

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Every engineer knows that if any ordinary engine were by accident to run away at this pace it would knock itself to pieces, or its bearings would become red-hot, and, at all events, if it could exist it would do no work. The inventors have had to design new valves to admit and cut off the steam with adequate speed and effect. New mechanism has been contrived to open and shut these valves, in order to combine speed with gentleness. While many parts of the engine have had to be lightened, in order to move with quickness and ease, other parts, and especially all bearing surfaces, have had to be exaggerated and spread out in order to induce the rapid reversals of strain and admit of adequate lubrication. Then the whole framing of the fixed parts requires unwonted solidity and unflinching truth, for even very slight vibration would lead to rapid decay. In short, the cylinder and all the fixed parts require to form, as nearly as possible, one immovable solid mass; the piston, the crank, and all the moving parts, one single, continuous, flexible series of links, fitting perfectly, without a flaw.

Such is the formidable enterprise which the authors of this engine have boldly undertaken. To add to its difficulty, it is a condensing engine; and when I say that the piston of the air-pump of the condenser is a plunger moving in the hot-well 800 ft. a minute, it will be plain to every engineer that the engine is a *tour de force*. That it maintains its racing pace of 800 ft. a minute in practice anyone can ascertain who stands by and counts the number of strokes a minute, and there remains but one question, which cannot be decided there. Can this engine endure? Will it last?

I have no hesitation in saying that for a long time, at least, such an engine will require to be watched with skill, knowledge, and care. Intelligence, education, and training beyond our ordinary level of skill and knowledge will be required, both in the construction and in the use of these high-speed engines; but so it is with most modern improved machinery. The rifle-gun and the needle-gun demand more perfection in the machinery for their construction, and greater intelligence, education, and training in the soldiers who use them, than in those who fired old Brown Bess. It is thus, perhaps, that improved machines may react on the human beings who improve them, and render a still higher technical education necessary in the race who are to live by their labour. But, come how it may, this engine is certainly a steam-engine of the future.

Other English exhibitors.

There are other English engineers who have sent to Paris creditable examples of good standard engines. Bryan Donkin & Co., of London, have maintained their old reputa-

tion by sending an engine entitled to the credit, not only of being ably designed and well executed, but of containing some modern refinements for working expansively and saving fuel. Messrs. Hick & Co., of Bolton, who have so long been known for their successful application of the double-Woolf principle to stationary engines, have sent a horizontal engine, with a peculiar mechanism for working four separate valves, which enables the governor of the engine to regulate the varying expansion of the steam after the manner invented by Corliss, and have shown a laudable ability both to appreciate that invention and to introduce it successfully into English practice. Messrs. Ransome and Sims, of Ipswich, have sent two of their best portable agricultural engines to drive the machinery of the Exhibition—one of them, the simplest engine, fit for rude agricultural hands; and the other, a more refined engine, economising fuel by a due adoption of modern refinements without going much beyond the average level of the rustic mind. Mr. Galloway, of Manchester, and Fox Walker, of Bristol, exhibit fair specimens of ordinary engines, which show that strength and simplicity, even without modern refinements for saving fuel and giving out carefully-measured speed, are what the general English public wants and appreciates; and Mr. Thomson has sent his astonishingly-ingenious rotatory-engine to challenge the ingenuity of all nations.

Models and small boat engines.

Besides the large engines sent to work in the Exhibition, some of our eminent firms have sent either models or small boat engines, more as a mark of good feeling towards the Exhibition than as a matter of business. Mr. Penn shows a model of his 1,350-horse power engine, which he has presented to the Conservatoire des Arts et Métiers as a souvenir of the hearty welcome given by General Morin and M. Tresca to the Society of Mechanical Engineers of England within the walls of that admirable technical university where they give such valuable and varied courses of instruction to the rising generation of French mechanical engineers. Messrs. Rennie, Ravenhill, Humphrys, Denny, and some other engineers have also sent small engines or models which somewhat inadequately apologise for the absence of the more important works they might have sent there had they thought fit.

## France.

France.

Great progress in manufacture of Prime movers.

France naturally predominates in this exhibition of prime movers; first, because she is on the spot, and it is her special business, as well as a point of honour, to make it a success; and, second, because she has enormous progress to show in

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this great branch of engineering, in which she was not long ago immeasurably behind us, and in which she has rapidly and abruptly made a rush up to us at high speed. That she has as yet surpassed us it would be very hard for us to admit; but that her recent progress has been more rapid than ours we frankly admit, and we give her full credit for having profited, not only by the study of our experience, but for having drawn upon the original sources of her own national ingenuity. The great marine-engines of Indret, which pump the waters of the Seine into the lakes of the Exhibition, are not finer examples of marine-engines than the same class of engines exhibited by the Forges et Chantiers de la Mediterranée; by Mazeline, of Havre; and by Schneider, of Creusot.

Indret.

*Indret.*—It is only fair to the ingénieurs de la marine of France to admit frankly that their present modern system of engines is original, is their own, is little copied from ours. Had M. Dupuy de Lome's engine been invented in England it would have been sustained as an original invention, and might have been patented as his own. It is, as I have said, a three-cylinder engine, and three-cylinder engines have long been known in England and partially used there; but what is original is the use of a three-cylinder engine to work expansively on the Woolf system, one cylinder high-pressure and two low-pressure condensing cylinders. The practical arrangements for carrying this out by three equal cylinders were far from obvious, and it required no common skill and determination to work this out, so that the two sets of advantages should be thoroughly combined—one the advantage of obtaining uniform power in equal quantity throughout nearly the whole stroke from all three cylinders, the other the advantage of working to a high degree of expansion. Of the uniformity of the power given out by the three cylinders, the steam-diagrams I have examined have satisfied me; and of the reduction of maximum strain on the parts of the engine there can be as little doubt. The practical result of saving of fuel appears to be attained to as high a degree as in theory it should be, and the advantages gained in the durability and good condition of the engines are attested by the fact that hot bearings are said to be unknown in these engines, even at their highest speed—a fact which seems confirmed by the absence of all ordinary provision for cooling heated bearings.

M. Dupuy de Lome's three-cylinder engine.

The general arrangements we have spoken of are common to the Indret engines, and to the engines of the same class made at Creusot, La Seyne, and Havre; but the engineers of each of these establishments have exercised their choice in mechanical expedients, and have each carried out the common

principle his own way. There is plainly much to choose in the way of carrying out such a construction, even after its great features are decided; but the following points are common to all:—1. The steam is superheated, and is carried round the jackets of the two condensing cylinders, but not round the high-pressure cylinder, the reason being that it is a fault in the former to be too cold and a fault in the latter to be too hot. 2. All the cylinders are plain, equal cylinders, laid side by side, and bolted into one solid mass. All of them are double piston-rod cylinders, with no trunk either in air-pump or cylinder. 3. The valves are not worked by eccentrics on the main shaft, but by cranks on a secondary shaft revolving by gear with the speed of the main shaft. One object gained by this is to leave the whole main shaft free for very large bearings. 4. The valves are the common long D slide valves. All the valves are alike; all their motions are identical, and give identical cut off; so that—given three cylinders and three cranks, the number of parts is small, and complication is sedulously avoided.

The general distribution of the engine is simple and symmetrical. On one side of the shaft, side by side, are the three engines; on the opposite side of the shaft are the two condensers, leaving an opening in the centre. The high-pressure cylinder wants no condenser opposite to it; and, as it needs no air-pump, it has instead a large water-pump, which can be used for the safety of the ship. The cylinders on one side and the condensers on the other are all firmly united, so that the whole engine forms a single independent structure, receiving no aid from the strength of the ship, which in the French navy is generally built of timber. The boilers are large, roomy, effective, durable; differing in detail, but of the same general character, as our own marine-boilers.

### Forges et Chantiers de la Mediterranée.

Marine engines by

These works exhibit a pair of their ordinary marine engines, and also a skeleton of a three-cylinder engine similar to that we have just described in the same building with it; but they also exhibit in the interior of the Exhibition a complete series of models of marine engines from 1,000-horse power down to the small pony or donkey engine. Such a series of models is extremely instructive, and shows the great variety of resource the marine engineer must have at his command, in order to solve the continually-varying problems put to him. There is a model, for example, of a pair of diagonal paddle-wheel engines, meant for a light, long, shallow boat, and therefore spread out over as great a

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length as possible—one forward and one aft of the single crank on which they both work. There is a vertical trunk-geared engine for the screw. There is the modern three-cylinder screw engine, such as I have already described. Then a two-cylinder screw engine, having its valves worked by eccentrics from a second shaft, independent of the screw shaft; and next to it there is a similar engine very differently arranged, with its eccentrics brought to the outside and placed on the main shaft, and there it has both the ordinary slide valve and a cut-off valve, worked each by an independent link motion. Further on is a pair of inverted vertical screw engines, of the sort we call hammer engines, to which a large central square condenser forms the nucleus of a very rigid framing, which nevertheless leaves the engine conveniently accessible. This whole collection shows a progress of thinking and of working that is both systematic, versatile, and very instructive. Just such a series ought to be possessed by every school of engineering or naval architecture.

M. Mazeline.

*Havre.*—M. Mazeline exhibits a large three-cylinder engine, of the class of the navy, of which the details and arrangements are carried out in his own peculiar way; and this engine is as good as we should expect from his established reputation as a maker of marine engines. Among the models exhibited in the interior of the building is one of 1000-horse power, for the Magenta class of ship, which has been presented by M. Mazeline to the school of naval architecture in Paris.

M. Normand.

From Havre also is sent a clever and ingenious two-cylinder screw engine, by M. Normand. It is an inverted vertical engine, but has the merit of carrying the double cylinder Wolff system into effect in a manner at once simple and good. Two jacketed cylinders side by side are worked by valves lying between them—one is high pressure, one at low pressure; and to the eye the engine is quite as simple as though it were an ordinary pair of identical engines. It looks an engine that would both be effective and economical.

M. Schneider.

*Creusot.*—Schneider, of Creusot, exhibits a pair of marine engines of 265-horse power, which are handsome, simple, compact, and strong. They are peculiarly well arranged and accessible. Beside them he exhibits marine engines of 950-horse power, three-cylinder engines on the plan of the Imperial navy, regarding which it is impossible to say that engines could be better designed for strength, durability, and effective work. They are meant for the new class of frigate, like the Marengo.

Admirable character of his works at Creusot.

But the most remarkable circumstance in the Exhibition which contains these and some other of the admirable engines of M. Schneider is the exhibition he makes of the way in which workmen are reared, educated, and trained to design, construct, and finish these engines. Not merely are the materials and fuel found underground near the establishment, and the ore smelted as well as fashioned on the spot, but the workmen are "raised on the premises." M. Schneider's works are inhabited by 24,000 souls, over which large colony he is the presiding genius and providence; and if there be anything more admirable than his engineering work it is the forethought, care, and affection with which he studies their well-being, and provides for their well-doing. He begins by providing for them well-ventilated, cleanly, roomy, wholesome dwellings. He next provides for them all, without distinction of age or sex, a series of schools, which all attend, where all the men are not merely educated to read, write, and count, but receive continuous instruction from their youth up in the theory of mechanics, the laws of physics, and the principles of chemistry. They are all taught hand drawing, geometrical drawing, mechanical drawing, and light and shade. His young workmen, reared by alternate life in school and workshop, are so well trained and taught that his difficulty is to keep them after he has reared them, for so coveted are his youths for their excellence that they are bribed away to become the foremen and designers of other workshops, and he wisely, instead of begrudging their promotion, aids their success and rejoices in it. There is not in all England, even for the higher classes, such an admirable system of technical education provided as the boys and girls of M. Schneider's works freely obtain. When will the time come for England when every group of 24,000 working men, women, and children will receive an equivalent universal systematic technical education for the specific duties of their particular calling in life?

Technical training.

*St. Ouen.*—As it is impossible to go through the long list of meritorious makers of steam-engines in France, I will give, as a type of the better class of manufacturing engine, a description of those of one firm, the Messrs. Farcot, of St. Ouen; and I select them because they are to a great degree typical of the peculiarities of the best modern manufacturing French engines, and particularly well exemplify their differences from our own. These engines of Messrs. Farcot are also more numerously employed than any others in driving the machinery of the Exhibition. It may be said to be characteristic of the French manufacturing engines that they care less for extreme simplicity and place less value on great

Manufacturing engines by M.M. Farcot.

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weight and mass than we do. What they set store by is very effective and wise lubrication, large bearing surfaces, and extreme economy of fuel. Moreover, they seem to set more value than we do on getting their engines to maintain in every variety of circumstance uniformity of speed. They seem to require, as the *sine quâ non* of every engine, that you should be able suddenly to throw off one half or two thirds of its work, and that the engine should so regulate its own supply of steam as not to go the least sensible degree faster from its lightened work, and that you should be able also suddenly to double or triple its load without the engine seeming to feel the change or manifesting the least retardation of speed. For these two points—economy of fuel and invariability of performance—the French seem willing to incur greater cost of engine, somewhat greater complexity, and more refined artifice than owners of engines in England would generally be willing to incur or pay for. In England there can be no doubt that our best engineers can provide similar refinements and obtain equivalent results. The only question is whether the owners would not prefer the cheap rude engine, profuse of fuel, to the dearer and more delicate machine requiring greater delicacy of handling and nicer appreciation in its owner, and also requiring a more educated, intelligent human being to tend it and bring out its good points. And I may here say generally for the constructors of engines that the limits to practical improvements are found to lie much more in the degree of intelligence of the owner and the degree of education of the caretaker than in the knowledge or ability of the engine-builder.

The Farcot engines are, for the most part, simple horizontal engines, of good proportions, solid base-plate, rather large bearing and rubbing surfaces, simple in their structure, and somewhat highly finished. For many years the aim of these makers has been to obtain economy of fuel by working expansively to a rather high degree. To attain this they introduced, early in the history of these engines, the means of working expansively with the regulation of the ball governor. They found, no doubt, as other people had found before them, that the governor, as it is commonly applied, is anything but a regulator. It changes the variations of motion, but does not prevent them. They have done their best to make the governor an absolute regulator. The degree to which they have succeeded in doing this has given their engines a high reputation, and the application of the governor to do this by means of variable expansion has made it pay.

The cut-off takes place in their engines by a moveable cover on each of the two steam-ports, immediately on the

back of the ordinary slide-valve. The variation of the cover or the cut-off is done by placing a curved cam between these two moveable covers. This cam has two opposite leaves, one for each slide. The cams are mounted on an axis, which projects from the valve-chest through a stuffing-box, so as to be got at from the outside.

To regulate this cut-off by hand is, therefore, extremely simple. By turning the axle a few degrees one way or other, you put the cam either nearer or further from the valve, which it therefore meets sooner or later, and so shuts off the steam quicker or slower. But it cuts off quite sharp and clean, with a click (which none object to), and gives an elegant diagram.

So far the matter is quite simple. What follows is less simple. The shape of this cam is evidently a matter of choice and study. It may be of any curve you choose, and each curve will make a difference in the degree of cut-off, for each angle of the axis of the cam. The choice of this curve is one of the merits of construction of the engine. It is evident that the curve must embody two considerations—consideration of the change of angle of the balls of the governor with a change of speed, and consideration of the effect of change of degree of cut-off upon the speed of engine. It is the duty of the curve of the cam to reconcile these two independent elements.

There is a known difficulty in the change of speed arising out of the nature of the governor itself. It is not a cycloidal pendulum; it is imperfect. To correct it approximately M. Farcot altered its arrangements by carrying its bars across the central axis to a defined initial angle. He got out of his governor in the first instance, before connecting it with the cam of his steam valve, what he considered a very definite relation of position to speed. Having got his steam valve on one side, and his governor on the other, into a definite variation of required movement, he was able at last to determine the true curve of equal speed for his cam. That he has got his cam actually at the right curve one can only infer from performance. He has the reputation of having done so; and, as far as one can judge from such tests as a spectator can be allowed to apply to the machines at work in the building, he has attained a high practical regularity, under abrupt changes of work, that is creditable to French engineering.

The telodynamic machine of M. Hirn, which I have already described among prime movers, is exhibited in the French department, supplying water to the building.

From the whole survey of the French department, it is impossible to resist the impression that the admirable system of national technical education for the mechanical engineers

Marke effects technical instruction in the de-

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velopment of practical engineering in France.

of France, which receives its impulse from the great Ecole Centrale, in Paris, and from the Conservatoire des Arts et Métiers, and which is rapidly being extended through local schools to the engineering population of the provinces, has produced very marked effects in developing in practical engineering the characteristic ingenuity of the nation. The marine engineers of the navy, both those who are entrusted with the architecture of their ships and those who design and construct their engines, are all men who pass into the dockyards through a long career of preparatory technical schools, and who first distinguish themselves in the Polytechnic School of Paris before they can aspire to become students in the College of Marine Architecture. It is thus that, in all departments of French engineering, education and science are everywhere visible; and if it be required of me to account for the greater rapidity of progress of the French in matters of engineering during the last 10 years, I can see no other cause for it than this superior organization for technical education, as part of which they have as much as possible of practical knowledge communicated to them in addition to their scientific attainments. I do not think our nation inferior to theirs in technical ability, personal energy, or in the skilful use of our hands; it is only in the want of organized education that I can indicate any cause of our inferiority or any remedy for it.

United States.

## America.

It is impossible to look at the steam-engines and machinery exhibited in the American department without admiration. They exhibit little, as might be expected so soon after a long and eventful civil war; but what they show has the stamp of originality, and is characteristic of that educated and adroit generation of young engineers now coming up to the work of America.

Characteristics of American engineering.

Two things are remarkable in American engineering: directness, for they go right at their work, and reject expedients that are not simple and straightforward; eccentricity, or originality, for they do things in ways we should never dream of. We should follow precedent as far as we could, and only abandon it when we could got no further with it. They throw the past overboard at once, and, looking only at the purpose and the future, go right ahead, and run down the problem by clearness of comprehension and directness of expedient. Hence, their machinery is as unlike ours as possible.

But, because they are unlike us in their way of working, the study of their work is to us most instructive. It quickens

Steam-engine by Mr. Corliss.

our invention by startling us out of our conventionalities. They produce a steam-engine of Mr. Corliss, which is unlike anything English. Nevertheless, we soon reconcile our minds to it; for we find that, although they have done everything differently from us, they have done the things which we must approve. Corliss's engine is meant to be compact, solid, true, durable, powerful, and parsimonious—all high qualities—and it is symmetrical, well proportioned, well executed, and well put together. The general arrangement and design is unexceptionable.

Its smaller members are not to our engineering taste; but it is impossible to deny to its parts thoughtful plan and fitness of purpose. It has, as I formerly said, four valves instead of two; but the aim of these is to save waste in passages. It works the two steam valves separately from the two escape valves, but the object of that is to vary the quantity of steam to its varying use and purpose. The mechanism by which the governor alters the quantity of steam admitted, so as to fill a larger or smaller volume in the cylinder, accordingly as it has more or less work to do, may appear at first sight to be delicate and complex; but the work it has to do is as delicate and dexterous as that of a human hand, which is itself complex after the same fashion, and the multifarious parts of the mechanical hand and mechanical fingers of this mechanical governor rule the work of the engine and equal judgment to that of the strongest human hand and gentlest human touch with better adjustment; and it is impossible too much to admire the thoughtfulness and the refinement of this arrangement for varying the development of the power of this engine, so as always to get only as much work as it wanted, and to get it always with both uniformity of speed and the parsimonious use of steam and fuel. An English engineer should study that engine, and then—try to "the better example."

Ingenuity of American inventions by which steam power is applied to skilled handicrafts.

American mechanisms for doing the operations of skilled handicraft by steam machinery are very worthy of note. All the operations of the joiner, carpenter, and sawyer, have been done more or less well by machinery, much of which grew with the timber on which it is used in America. There are shown in this Exhibition several machines of singular elegance for the fitting and finishing of wood-work. There is a lathe, into which you insert a square rod of wood. It revolves, the corners are taken off by one tool, it is smoothed round by a second, it is roughly shaped to a decorated pattern by a third, and a fourth large, polished, single blade, covered with convolutions, comes straight down along its edge, and leaves the block of wood a finished, smooth, ele-

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gant staircase railing. An unpractised hand with this machine produces three finished turned bars per minute. It is one of those inventions which make it well worth the while of a civilised nation to train its skilled people to taste, refinement, and beauty; for, just as Nature multiplies a beautiful plant or an ugly weed, so will this machine equally fill a city with the most delicate and refined articles of beauty or with vulgar and hideous deformity. These machines give the user beauty and ugliness at equal cost. To a refined, educated people they are a blessing. In vulgar hands they are engines for spreading vulgarity and diffusing bad taste.

Comparison of American withEnglish rotary engine by Mr. Thompson.

There are one or two rotary engines in the American department which it would be very instructive to compare with the rotary engine of Mr. Thompson exhibited in our own. Mr. Thompson's cylinder contains two pistons, which during their revolution go faster and slower, get nearer or further asunder, and so form between them a variable volume, which the steam on entering enlarges, and from which, when diminishing, the steam escapes. These two motions synchronise with the motions of two toothed wheels of variable diameter outside, and so a uniform speed on the flywheel is reconciled with the continually varying or differential speed inside the cylinder. In the American engines, on the other hand, there are drums revolving within another drum, but with portions taken out of one and out of the other, which leave spaces between that are continually enlarging or diminishing, receiving a charge of steam and discharging it alternately. The comparison of these American and English engines exhibits various differences with real ingenuity on both sides, and each is the work of great thought and clever device. One of the American rotary engines is united to a rotary pump; and, seeing the two together, one cannot refuse to admit that the union is a fitting one, and that the two were made for each other. Even an unbeliever like myself in any superior economy or duty obtained by a rotary over a reciprocating steam-engine, may willingly admit that the convenience of directly applying a revolving motion may warrant the use of a rotary engine as a point of utility and convenience, even if it fail in economy of fuel, which is not always the point of highest value.

Steam-blower by Mr. Roots.

Another singular American invention is a steam-blower or bellows, or ventilating apparatus. It is meant to be a substitute for the modern fan-blower, and also for blowing-engines of all kinds. Its peculiarity is that, like the fan, it is a revolving blower, and that, unlike the fan, it is a forcing blower, and acts against increasing resistance with a force

proportioned to the resistance. It therefore unites the good properties of the revolving blower and the reciprocating blower.

The mechanism of this blower is curious, and deserves the attention of our engineers. With our fan-blower we are obliged to get the speed necessary to a given pressure in order to obtain that pressure. With this blower we may go as slow as we please and get as high a pressure as we desire. It is an instrument capable of multifarious application and easy regulation.

The plan is not an untried design; it is a machine in large practical use in blast-furnaces and in iron-smelting in America. It is made by Mr. Roots, of Connersville, who, I believe, is its inventor.

The mechanism of this blower consists in two drums which revolve on two parallel shafts inside a third drum. Neither the two inner nor the outer drums are cylindrical. The two inner are elongated one way and narrowed the other way, so that when they both revolve their surfaces fit into each other —the long axis of the one into the short axis of the other. Their form is a beautiful piece of geometry. The problem solved is this—given, two wheels with only two teeth in each to make them revolve together with equal and uniform speed, and so as always to fit each other and also the inside of the third drum. This they do so as to divide off the outer drum into two cells, one cell always receiving fresh air and the other always contracting upon and squeezing out air already filling it. This curious pair of eccentric inside cylinders are the only mechanism in the blower, which has neither valves, passages, nor ports, except an opening on one side to admit air and one on the ther side to blow it out. The two inside cylinders have two shafts and two equal-geared wheels outside the outer drum, which give them revolution. It is a machine to reward study, and it is difficult to determine beforehand the advantages or disadvantages which may measure its relative value.

Perhaps no more instructive comparison could be made than between this small engine and the gigantic blowing engine of Mr. Cockerill in the Belgian department.

A small steam-engine, of short, quick stroke, in the American department, drives a rotary pump of the same sort as our own Appold's pump; but the elegant spiral form given to the driving part of the casing is very expressive of the true principle of construction of this class of hydraulic engine, and gives one the assurance that the engine is well thought out and contrived. The steam-engine which drives it is curious as a sample of an oscillating engine whose own oscillations drive

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its valves. I do not feel certain that the simplicity of this system quite reconciles one to the somewhat rough working which, perhaps inevitably, attends this fixed valve. It seems as though the steam-engine were less refined than its associated water-wheel, which seems to do its work effectually as well as smoothly. This pump may be compared with our own rotary pumps without disadvantage to either.

Belgium.

## Belgium.

Steam winding engines.

Like ourselves, Belgium is rich in coal; and among its foremost steam-engines gives us examples of those used in drawing up minerals from her deep mine-shafts. Dorzée, of Boussu, exhibits a pair of steam winding engines working on one crank-shaft, which show a careful study of the points that render these engines safe and reliable. The general disposition of the engines is judicious. Two inverted cylinders stand over the two ends of the winding-shaft. They stand on the top of two conical towers of cast-iron, which spread out and form a base to the engine and a seat to the crank-shaft at each end. They have excellent arrangements, which not only indicate very clearly the place of the bucket vertically in the pit both to the eye and to the ear, but they have self-acting mechanism to avert danger in extreme case of neglect. The engines themselves are very excellent pieces of engineering design and sound work. The Chatellineau Company also exhibit engines of a similar general design and construction.

Other steam engines.

Two steam-engines are shown by Vandenkerchove, of Ghent, which show the application of much ingenuity to the purpose of generating most power from least steam. These engines exhibit the two methods of accomplishing this, which rival each other throughout the whole Exhibition. One is a horizontal single-cylinder engine, working expansively; the other a double-cylinder engine, working high-pressure in one cylinder and expanding and condensing in the other. They are horizontal engines. The peculiarity of the valves of these engines is that they work slide valves of very short stroke and many narrow openings; that they have four independent ports, and that each port has a separate curvilinear revolving cam on which it works. In the single engine the two steam ports are on the side, and the eduction ports are below the (horizontal) cylinder, which they consider to have the advantage of facilitating the escape of water from the cylinder. The pumps of this engine are worked by a double rocking beam, worked by a link from the piston-rod compactly and directly. The pair of high and low cylinders

are side by side, with slide valves lying between them for transmission of the steam directly out of the high into the low pressure cylinder. This is rendered practicable by having a second crank, which reverses the motion of the first cylinder in the second. The valves, worked by cams, deserve study; the cams open and shut the valves very quickly, and admit of free choice in quickness, quantity, and time of motion. They are made very broad, to give surface and durability. They work smoothly and easily. The governor works the steam cut off by shifting the cam, which is graduated. The whole of the arrangements show skill, study, and originality.

Cockerill, of Seraing, exhibits a blast engine for blowing large iron smelting-furnaces which possesses some curious features in the application of the steam-engine to a special purpose. Ordinary forms of steam-engines have many points ill suited to the purpose of blowing air; the sudden jerk at the commencement of the stroke when the steam pressure is highest occurs when the resistance of the air is lowest, and the falling off of the steam pressure as the stroke advances is a circumstance inevitable in a good application of steam to an ordinary steam-engine, and yet quite unsuitable to an air-blast engine. The special manner in which this evil is removed and the engine rendered of remarkably uniform pressure is this:—On a high frame stands an upright blowing cylinder, some 8 ft. diameter and 8 ft. stroke; vertically under it, on the level of the ground, stands a pair of high and low pressure cylinders, their piston-rods acting on a single cross-head. This cross-head also carries the piston-rod of the blowing cylinder, and from its ends hang down the connecting rods of two flywheels, of which the shaft is under the cylinders and serves to work the valves of the steam-engines. The cross-head works in slide guides. The valves are worked by revolving cams, and are equilibrium lifting valves. By this means it is plain that a high and low pressure pair of engines coupled side by side gives this the uniformity of pressure of the Woolf's engine in a very direct, simple, and efficient way, and form a very economical and good application of power.

There is an interesting form of Woolf's double-cylinder engine, shown by Rens and Colson, of Ghent. The high pressure and the low pressure are in one line, the former having one piston-rod, the latter two piston-rods. There are two pairs of cylinders working two cranks on one shaft, which carries a toothed flywheel. The three piston-rods of a pair of cylinders join on one cross-head, and drive one connecting rod along slide-guides. The valves are very simple, and move by eccentrics. The faults of these engines are the

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lengthy steam-passages used, and the want of graduated cut-off by a governor.

There is a very compact pair of horizontal condensing engines, exhibited by Huguet and Teston, of Verviers, combining the good points of a marine engine and a land engine, and having a governor regulating the cut-off much in the manner of M. Farcot; and also a pair of vertical Woolf beam-engines, working two cranks, and driving its valve-gear by bevel-wheels, with eccentrics and curved cams under the valves; but this latter does not regulate the cut-off by governor.

Taking the Belgian engines as a whole, they display considerable versatility in varying their engines to the peculiarities of special use; but they hardly possess the same refinement of adjustment to extreme economy of fuel, or the finish and completeness of design, which distinguish the best French engines.

Prussia.

## Prussia.

Although Prussia has sent examples of her skill and wealth in iron and steel manufactures to Paris, it is not in steam machinery, but in gunpowder engines of war, that she is best represented. She is admirably represented in works in steel and iron, the produce of knowledge and skill in the construction of prime movers and in the applications of them to manufacturing use; but she has not sent the engines required to drive even her own machinery, except a small pair of high-pressure engines, from Aix-la-Chapelle, by Demense Houguet and Co., working two cranks on a fly-wheel shaft, and having valves cutting off by the governor. Egells, of Berlin, show a steam-engine which works two hydraulic pumps that drive a steam hammer. There are also shown, by Aders, of Magdeburg, two cylindrical boilers, half filled with tubes, which prove how the used-up steam of a high-pressure engine may be economically employed in evaporating sugar and so turning all the heat of the waste steam to account. But this is the scanty list of Prussia's triumphs in steam; and it must be regarded as a civility and exhibition of good will, rather than as a *tour de force,* that she sends these.

Austria.

## Austria.

Austria and the other German States have, like Prussia, been otherwise employed than we could desire, and their exhibition of ordinary manufacturing steam-engines is quite inferior to their normal resources and skill. A single over-

head beam-engine alone represents her; but it has a Woolf pair of cylinders, cut-off valves, and Watts's old parallel-motion, showing a combination of good if not new things.



### Bavaria

Bavaria.

exhibits an elegant, well-constructed little pumping-engine, the steam cylinder, pump-barrel, and regulating crank-shaft of which are all in one horizontal line. There is great symmetry in the whole distribution of the engine and its parts, thoughtfulness in the general working out of its details, and elegance in its finish, and it governs by a cut-off very directly connected with the governor. It is by Dingler, of Zweibrucken, and is so good a sample of Bavarian engineering as to make us wish for more.

### Spain, Portugal, and Greece

do nothing except to show us that they have begun to study the alphabet of engineering.

### Russia

Russia.

shows that she is determined on rearing a portion of her people to the mechanical arts, and has begun well by establishing an "Ecole Impériale Technique" at Moscow, of which she sends samples of the work in steam-engines built by the pupils, and samples of the system of their technical education in some good models provided for their instruction in machinery.

Technical instruction.

### Italy

Italy.

sends samples of the long famous smith-work of the artificers of Genoa, and of her beautiful ironworks at Lecco, on the Lake of Como. The forgings by Ansaldo, of Genoa, are large masses prepared for marine engines of 900-horse power, and show the ambition and ability of Italian engineers. Westermann, also of Genoa, sends a small pair of horizontal screw engines to represent the goodwill of Italy.

### Sweden,

Sweden.

with her fame for iron and all the crafts belonging to it, could not remain unrepresented at this Exhibition. Frestadius, of Stockholm, sends an exceedingly clever modification of the Woolf double-cylinder engine. It is a horizontal crank engine, with slide-guides and a single crank. One cylinder is put inside the other, and, as it is the high-pressure and

Engine by Frestadius.

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hotter cylinder, it radiates heat to the outer or condensing cylinder, which, with an outer jacketing in addition, can thus be kept doubly hot, while at the same time the heat of the inner cylinder is mitigated. The outer cylinder has two piston-rods, the inner cylinder one, and the three unite in the cross-head which drives the connecting rod, and which also drives the engine-pumps. The governor regulates the steam very directly, and the engine is just such highly respectable a piece of modern engineering as we should expect from the experience and intelligence of Swedish engineers.

Carlsund, of Malata, exhibits a very elegant little vertical screw engine as another specimen of Swedish prime movers.

Switzerland.

## Switzerland.

There is very little sent to Paris from Switzerland to represent the steam-engines of that ancient democracy. Fuel has always until now been dear in that high region, to which it is raised at great cost. Their high mountains and the constant flow of their glacier-streams give them gigantic water-power in profuse abundance to serve as prime movers to all the machinery they will want to drive for many years to come. The iron cord of M. Hirn will economically and effectually distribute the power of the huge masses of their rivers through their manufacturing villages and yield a power at once cheaper and more convenient than steam. It is not therefore surprising that the enterprising Swiss are not profuse in their production or show of steam engines.

Marine engines by Escher, Weiss, & Co.

There are, nevertheless, applications of power to which water-power will not apply. Steam-ships are abundant on the Swiss lakes. The firm of Escher, Weiss, and Co., of Zurich, has long earned and held a high character for lake steamers. They represent Swiss navigation by a pair of marine engines of their peculiar form. They are inclined cylinder engines, which are suited to shallow water, and which have much pains bestowed on them to render them both light and strong. Their framing is to a considerable extent of wrought-iron, and they are direct acting, with a slide-guide to the connecting-rod.

Engine by Sulzer.

Another Swiss steam-engine is exhibited—a fixed horizontal engine for driving manufacturing machinery. This engine is a creditable sample of Swiss engineering design and manufacturing skill. The iron castings are beautiful specimens of the founder's art. The engine is horizontal. A single casting forms the block on which the crank-shaft rests, as well as the end to which the cylinder is bolted, and serves for the guides

of the connecting-rod by slides, which are slightly round in section. All this work, which forms a continuous bed and framing for the engine, is stout, strong, and simple. But it is in the valves and valve gear that the peculiar merits of the engine lie. Economy of steam is, as may be gathered from what we have said, a high point of merit in Switzerland. This cylinder is jacketed with high-pressure steam, which passes through the outer casing of the cylinder to the top side, and is there admitted by two lifting equilibrium valves of peculiar construction, close down on the cylinder, which open and shut with very slight motion. The exit valves are on the bottom of the cylinder. Both steam and eduction valves are worked by curvilineal cams, instead of eccentrics. These cams revolve on a shaft driven directly from the crank-shaft by toothed gear. The cut-off is governed by the centrifugal balls, which modify by a wedge the action of the cam on the valve. The whole of this valve gear is unusually light, indicating that the valve pressure is carefully equilibrated. This engine indicates conscientious solicitude for good workmanship and well-informed skill in economical contrivance. It is by Sulzer, of Winterthur; and we congratulate Switzerland on having, in Zurich and Winterthur, two promising schools of mechanical engineering.

Conclusion.

In concluding this report on Section 52 of the Paris Exhibition I may remark that it would be unwise and unfair to judge the nations which appear here as if all nations were in Paris under equally favourable auspices. Some are remote and others at hand; some have had leisure to prepare while others have had none, and have at most improvised evidences of good will, and entered the lists of friendly rivalry as matter of courtesy merely. Belgium and England, close at hand, have no excuse from without, and both appear in large extent, and occupy proportionally large space. But all the States of Germany, like America, appear under great disadvantages of time as well as place, and so must be excused.

Even under those difficult circumstances, however, a few general conclusions make themselves felt through the Exhibition, that it is not necessarily the countries which are richest in the raw materials of manufactures which in modern Europe appear likely to occupy the most distinguished position as workers. Among the other effects of free trade, one of them is to equalise the price of the raw material in all manufacturing countries. This, therefore, leaves the race of competition more open to the skill, genius, and enterprise of the intelligent and industrious classes in those nations, and seems to indicate that the future prosperity of civilised countries may consist more in the wealth they possess of industrious, skilled,

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Importance of technical training.

educated, frugal, temperate, cultivated human beings, than in the mere quantity of brute matter which their soil covers or produces. If this be so, we cannot too soon read this great lesson of the future, nor too speedily enter upon the process of training our working millions for the future feats of intellectual athletics and technical accomplishments which will enable them to contend with the carefully-trained rivals who on all sides enter the lists against them. Our mineral wealth gives still a balance in our favour. The native genius of an English workman is, for truth of execution and perfection of finish, not inferior to that of any other race; and if he will only now determine that the people of no other country shall enjoy greater privileges than our own for the early and methodical acquisition of knowledge and skill, and shall not stop short of the highest degrees of cultivation, we may speedily regain that predominance which to the eyes of many we appear to be in danger of losing.

## REPORT on MACHINES and MECHANICAL APPARATUS IN GENERAL.—(Class 53.)—By ROBERT MALLET, Esq., F.R.S., Mem. Inst. C.E.

A CRITICAL report upon the vast and very various collection of objects embraced in this class must assume the dimensions of a treatise; and, to be exhaustive, would involve several such. All that is here attempted is to give in a condensed and popular form. 1st, some notion of the principal kinds of objects exhibited in this class; 2nd, to signalise the main points of improvement observable as having been effected during the last decade in some of the more important of these objects; 3rd, to notice briefly some of the chief objects of curiosity or interest in this class that may engage the observer's attention.

Scope of the class.

Whilst machines and mechanical apparatus (that is to say, the material contrivances by which force and motion are transmitted, transferred, or modified, in direction in *space*, or in their mutual relations to each other in regard to *time*—for this is all that machines, other than those which deal with molecular forces, electricity, heat, light, magnetism, &c., can do) admit of some great classification in relation to the speciality of their objects; such as machine tools, machines for spinning, weaving, paper-making, &c.; there yet remains in virtue of the multiplicity of aims and objects of human industry, a vast mass, whose ends and purposes are so various and distinct each from each, as to admit of little more convenient classification than to group them together under the very general and somewhat vague title of this class 53. But besides this great and heterogeneous mass of machines, apparatus, and contrivances—some of the two latter of which pass away occasionally from machines at all, as above defined—the class 53 in the Paris Exhibition of 1867 has been caused to embrace all prime movers of whatsoever sort, which are *not in motion nor engaged in supplying power*, for actuating exhibited machinery, or for pumping water, or for ventilation, or for any other purposes belonging to the Exhibition, or to its buildings or grounds. So that whilst steam-power to the extent of probably quite 1000-horse indicated power (that is, each horse-power being measured by 33,000 lb. being lifted to the height of 1 foot in each minute of time) is employed in doing work for the purposes of the Exhibition, and the engines

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so working are relegated to class 52, a much larger number of engines, not at work and possessing a total probably of much greater horse-power, are included in class 53.

and groups of objects contained in it.

The objects, then, of class 53 may be divided into five or six groups, and classified in something of the order of their relative importance, as follows:—

Group I.—All first movers, not in activity, whose efforts depend upon the direct conversion of molecular forces into mechanical ones, viz.—steam-engines, gas-engines, air-engines, or caloric-engines, as these are often called, and engines dependent upon the evolution or expansion in volume of gases such as ammonia. In this group is embraced all the parts, direct or ancillary, of these machines. Steam-boilers of many sorts, and all their numerous adjuncts; such as safety-valves, manometers, water gauges, feed-pumps, injectors, are here found, as well as smoke-preventing arrangements; and, as transmitting the power from the engine, or assisting in its motion or management, we have shafting and gearing; the bearings of these, and the various arrangements for lubricating them, automatically or otherwise; governors, or other regulators of speed; and many other detached arrangements relating to the working of engines.

Group II.—All first movers, not in activity, which render available for human uses some fragment of those mechanical *active* forces found pre-existent in the world around us, and which Nature herself in the order of the universe has already converted into such, from the molecular force given forth from the sun. These are (A) machines recipient of water power; *i.e.*, of the power derivable from the fall by gravity, of a certain weight of water per second from a higher level to which in some way it has been pumped up by the sun, to a lower level; and embrace water-wheels acting by weight, with or without impulse, of whatever sort; turbines, acting by reaction and water-pressure; engines, acting by fluid pressure usually on a piston; or (B) they are machines recipient of the power of atmospheric currents, due to disturbance of equilibrium in the atmosphere produced by the sun, such as windmills, &c.

Group III. may be formed of all sorts of machinery intended for overcoming the gravity of *solid* bodies, *i.e.*, for lifting such; comprising cranes and all sorts of lifts and of hoisting-tackle, whether fixed or movable, and whether actuated manually or by power.

Group IV., in the same way embraces all sorts of machines for overcoming gravity in *fluid* or *liquid* bodies, such as pumps of every sort—piston, centrifugal, chain, Noria's, &c.

—and in many different and special applications, such as to pumping air or gases, to the supply of cities or houses for drainage, for irrigation, and many others, including fire-engines, and whether actuated manually or by power.

Group V. includes an immense variety and number of machines or apparatus for the weighing or measurement of the volume of solids, liquids, or gases; and whether continuously (on new quantities) or not; and with or without mechanical registration of measures or weight, or of both. This embraces all sorts of balances (other than those for the purposes of science or liberal arts) and weighing machines, water meters, and gas meters.

Group VI. may be constituted of machines or arrangements destined for the transference of work, *i.e.*, of force and motion together, in any direction, to great distances. This would embrace hydraulic connections, straps, bands, wire-rope or clip-pullies, and the Telodynamic wire of M. Hirn.

There remains a vast mass of contrivances within this class, which, though more or less occupying one or other of these latter groups, as having other possible applications or ends than those for which they are directly exhibited, might be with equal propriety described in some other class This is no fault of the classification or arrangement so lucidly and well made by the French executive of the Exhibition; it is a difficulty inherent in any attempt to classify the gigantic mass of human productions, and of the same nature as that experienced in the cataloguing of every great library; and in either case, if there is to be either classification or catalogue at all, these can only be by now and then a little violently cutting the knot of the difficulty of a perfectly systematic arrangement.

As regards the localisation of the objects exhibited in this large class, a preponderant portion of all its groups is placed in the great machinery zone of the main building; the hydraulic first movers, the pumps, and many other objects being in the annexes upon the quay of the Seine. The cranes are found on the quay and in the park, as well as in the main building. The locomobiles are chiefly in annexes in the park, divided amongst the respective nationalities. There many stationary, fixed, or semi-fixed—*i.e.* nearly independent of masonry foundation—steam engines are also found; but the greater number of these are in the machinery zone. The fire engines are chiefly in the latter locality, but not confined to it. The windmills are in the park; the weighing apparatus and much small apparatus, is in the machinery zone, but some large weighing machines are external to the main building. More precise designations of

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locality are impossible, for objects of class 53 will be encountered in nearly every part of the display.

Steam engines.

The steam engines of this class may be separated into fixed and portable, the latter not including railway locomotives, which are in class 63, but embracing locomotives for common roads or highways. The fixed or stationary engines are of three or four principal types, viz., with vertical cylinders, direct acting or through the intervention of a vibrating beam or lever; with horizontal cylinders, with inclined cylinders, with oscillating cylinders. Again, in any of these types the engine may comprise a single cylinder, or two cylinders, one receiving high-pressure steam, which expands into the second cylinder, on what is frequently known as Woolf's principle. Lastly, on any one of these several types there may be a single engine, or a pair of coupled engines acting conjointly. And in all these forms the engines may be either condensing or non-condensing. Rotatory engines constitute a distinct class.

In 1862 one of the most noteworthy circumstances observable as to the engines then exhibited by both British and foreign makers was the prevalence of the type of horizontal cylinders. Some double-cylindered engines were also shown; but in general the tendency was evinced on the part of the makers to employ a single cylinder, and to expand the steam in that by a suitable arrangement of valves; in some, but not in many cases, and those chiefly confined to foreign engines, the expansion gear was under the control of the governor.

Double cylindered engines.

Allen engines.

This was markedly the case with the Allen engine, then first exhibited, and which undoubtedly possessed merits not shared by any other engine then shown. Engines of this make are shown on the present occasion. The chief examples shown, as being employed within the building and also without it, belong to class 52; though some of smaller power, not doing work, are within our scope.

In these engines, which remain still amongst the very best exhibited in 1867, expansion is affected in a single cylinder by peculiar valve and valve gear, admitting of variable valve motions, produced from a single excentric. These movements are of such a nature as to realise, as fully as perhaps is practicable, the best conditions under which dry and slightly superheated steam can act upon the piston. The steam admitted at the commencement of the stroke follows the piston at full pressure for a distance which may be as small as we please, and is proportionate to the resistance. It is then cut off without "wire drawing," and the remainder of the stroke is completed by expansion to within a certain dis-

tance of the end of the stroke, when it is discharged through ample and invariable areas, and at the instant these are opened, compression commences at the opposite side of the piston by the admission of steam.

The arrangements are such that these engines can run at the very highest velocity that safety will permit, and the Porter governor employed is delicately sensitive in controlling the great energy of the fly-wheel due to its high velocity. The result is that great uniformity of movement is secured, notwithstanding that the steam is employed at a very high pressure (three to four atmospheres), and may be cut off at a very small fraction of the length of stroke.

exhibited by Whitworth & Co.

It would be impossible here, or unaided by illustrations, to give an intelligible description of the details of these engines, which are now exhibited as British productions by Whitworth & Co. The employment of high-pressure and slightly superheated steam, quick expansion, varying in amount with the resistance, perfectly effected, yet without condensation at that side of the piston, freedom from back pressure, complete steam jacketing, and perfect condensation are, so far as the engine itself is concerned, the main objects to which theory points as conditions essential to economy of fuel. All these, as we have just seen, may be more or less perfectly obtained with expansion in a single cylinder.

It was as early as 1781 imagined by Hornblower that expansion might be more perfectly and advantageously, as well as economically, conducted by passing the high-pressure steam first into one cylinder, and thence causing it to expand into a second and larger connected cylinder, whence it was withdrawn by condensation. Hornblower was cramped by the existence of Mr. Watt's patent in carrying out his views fully, and it was not until the time of Woolf that the double-cylinder expansive engine, which has taken its name from him, got into much notice. Woolf and the earlier advocates of this construction maintained that expansive engines thus constructed possessed *theoretic* advantages over those having but one cylinder. This, however, is a mistake. There is no *theoretic* advantage whatever obtainable by a given amount of pressure and of expansion from a given weight of steam, in two cylinders rather than in one.

Advantages of double-cylinder construction.

There are, however, some *practical* advantages resulting from the double-cylinder construction, which, under certain conditions, quite justify its adoption.

In a single cylinder, the higher the pressure of the steam and the sharper the "cut off," the greater is the inequality of pressure upon the piston during the first and last portions of

its course, and hence the greater the tendency to inequality of rotatory motion against a constant resistance.

This inequality, which may become inappreciable in fast-beating engines, such as the Allen engine, becomes a serious evil in the case of engines such as those usually employed to actuate the machinery of factories, in some of which, as in fine cotton spinning, absolute uniformity of rotation is indispensable.

Such absolute uniformity cannot be obtained in the case of high pressure and short cut off, even by the use of very heavy fly-wheels and by coupled engines, when the rate of piston speed is moderate.

Now it may be proved that, with equal steam pressure and equal expansion, the difference of piston pressure at the commencement and end of its course is greater with one cylinder than with two, the piston area in the first place being equal to that of the two pistons acting conjointly in the second, and the capacities of the cylinders being such as to develop equal power in equal times.

Hence, for attaining the most perfect uniformity of rotation, the Woolf construction, with double cylinders, is properly adopted. The wide-spread use of this construction, as exhibited by foreign nations, as well as in some instances by Great Britain, constitutes the most remarkable feature of this class of the Exhibition. The arrangement of the two cylinders side by side admits of simple valve-gearing, and, if judiciously arranged, of little loss of steam in the passages.

There are many engines exhibited of this construction in various forms which have great merits, both in design and in execution. Amongst these we may specify the beam-engines of Carels, of Gand, and those of other makers, together with a horizontal engine, with the high-pressure cylinder inside the low-pressure, which is annular around it, by Bergsund, of Stockholm.

A steam-boat engine in the Swiss annexe, in which the small and large cylinder-pistons apply to different cranks of the paddle shaft, is not a favourable example of carrying out this principle in practice, although previously employed both in France and Great Britain.

The Corless engine, an American arrangement, in which, by peculiar valve-gear, the admission of steam and the cut off are variable and under control of the governor, while the eduction is invariable and always open and ample at the proper moment, is also shown, not only in its original form, as it passed from the United States to Germany, but as modified by Hicks in England. These engines possess great

theoretic perfection and beauty of arrangement; but the valve-gear is of a nature that precludes anything beyond a very moderate piston-speed.

A Corless engine in the Swiss annexe, by Gebrüder Sulzer, of Winterthur, with double-seated valves and peculiar valve-gear, is worthy of attention.

Amongst the other engines which deserve particular notice are the following:—

On the ground of excellence of design generally or in some particular, or excellence of workmanship and of material—Clayton and Shuttleworth's small horizontal engine, finished with exquisite exactitude and delicacy.

Westermann's, of Genoa, marine engines and steam-winches, of good sound workmanship.

An extremely elegant small vertical high-pressure engine, produced by the Motala Works, Sweden; whence also come some excellently well designed and executed feed or bilge pumps, with hollow plungers.

Spain, in the horizonal engines of Fossey and Co., of Guipuscoa, and in the large vertical engine of Alexander Herm, of Barcelona, proves that she can produce motors that are alike respectable in design and in execution. A portable little engine, with vertical cylinder attached to the cylindrical vertical boiler, of the latter maker, possesses much merit.

Winding-engines.

Several winding-engines for collieries, of Belgian and French make, are well designed and executed machines, and in the special details well suited to their peculiar work. Amongst the large factory engines produced by France those of Farcot and of Cail and Co. are remarkable. Boyer, of Lille, produces a noble horizontal single-cylinder engine of this class; as do also Gavrian et Fils, of the same town.

Several British engines, in addition to the Allen engine already noticed, are of fully average excellence, but present no features of peculiar excellence or novelty. Few engines are of more collateral interest than those constructed by the pupils of the State engineering schools of Aix, Angers, and Châlons, exhibited by the French Ministry of Public Works. A pair of double-cylinder inclined engines, by Bourdon, of Paris, deserve notice for the general perfection of the details (which, however, in one or two points admit of practical improvement) and for the extreme beauty and proportion of the cast-iron vertical framing.

Rotatory engines.

Amongst the engines which possess more or less of interest as departing widely from established types may be mentioned several rotatory engines, none of which even approach the solution of the difficulties inherent in this class, except one,

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which, however, is far from perfect. Direct acting rotatory engines have from an early period occupied attention, though at first, and for a long period, upon mistaken theoretic grounds. Almost all the purposes to which steam power is usually applied, if we except pumping, require the motion of the engine to be resolved into rotation in the machine or parts made to move. This was effected by James Watt by converting the reciprocating rectilinear movement of the piston into the continuous circular one, by means either of the sun and planet wheels, or of the very long known crank, which is the method chiefly in use to the present day. Watt himself, though he does not in words attribute theoretic advantages to the rotatory direct engine, seems yet to have entertained some such notion. Rotatory engines are, as inventions, of high antiquity; their history and antiquity Hero of Alexandria in his Πνευματικη describes the earliest; Branca describes another form in 1629; these were directly or indirectly engines of *reaction*.

In his first patent of 1769, and again in that of 1782, such engines are not only proposed and briefly described by Watt, but one form of a rotatory engine is figured by him in the latter, and another described in his specification of 1784. Watt appears to have abandoned such engines, after a considerable amount of experimenting with them. In 1798, Hornblower patented a rotatory engine in which two pistons revolved alternately in the same direction in the same cylinder, each piston becoming, during the period of rest, the *fulcrum* for the steam, in its action against the other or moveable piston. The detent by which the pistons were alternately thus arrested was highly ingenious; but after repeated trials he abandoned the engine, on the grounds of the great friction of its steam bearing surfaces, and the impossibility of keeping them long steam tight. In 1799, Murdoch also patented a continuously revolving rotatory engine, the pistons consisting of deeply toothed spur wheels engaging with each other, and each placed in one of a pair of intersecting cylinders.

Hornblower and Murdoch both showed arrangements by which these could be worked either as noncondensing or as condensing engines. Murdoch's engine was constructively identical with a rotatory water pump described long previously by M. Grollier de Serviere of Lyons in 1719, and it has been since reproduced in one modification or another again and again.

Routledge, in 1818, (Repertory Arts. 2 sec. vol. xxxiii,) patented various supposed improvements upon Watt's constructions of 1782, and is stated to have made engines that would work tolerably well for a time, though not with

economy. Carter also, in 1821, patented modifications of Hornblower's plan, but with no great success.

Supposed theoretic advantages of rotatory engines.

During the succeeding 20 years, in addition to many previous proposals, there were very numerous attempts at improvements of rotatory engines both in Great Britain and abroad, most of which professed to be based upon theoretic advantages supposed to be gained by saving the loss of power assumed to be due to the reciprocating action of the crank. It is one of the strange facts in the history of mechanics, that a man as able and well up to the dynamics of his day as Smeaton was, should have distinctly enunciated the false doctrine that there is a theoretic or necessary loss of power as given out by the piston when applied through the crank and fly wheel. He argues against the crank, "That great loss would be incurred by the absolute stop of "the whole mass of moving parts as often as the direction "of motion is changed, and that although a heavy fly wheel "might be applied to regulate the motion, it would be a "great incumbrance," *i.e.*, to the machine.

Tredgold, at a long subsequent date, fell into the very same error.

It is not, therefore, very wonderful that during the first third of this century inventors of rotatory engines abounded, who based their improvements upon the practicability of economising this supposed vast loss of power transmitted by means of a reciprocatory piston, crank, and fly wheel. It is at the present time scarcely necessary to affirm that no such theoretic loss exists, and that the entire loss, of power given out by the piston and thence passed into the revolving shaft or axis, is that due to the friction of the intervening parts where their surfaces slide over each other, and which is greater as the length of the connecting rod in relation to that of the stroke is smaller, or, in other words, as its oblique action is increased. There are not and cannot be any *theoretic* advantages then claimed for the direct rotatory engine; on the contrary, there is one positive theoretic disadvantage common to every one of the most feasible and practicable forms of rotatory engine, and from which it is more than probable that no amount of ingenuity will ever be able to free it. In such engines all the theoretic and actual advantages of expansive action are lost. The steam is admitted to the cavity of the drum at full pressure, and continues so during the whole period of revolution until the instant at which it escapes into the atmosphere, when all its residual heat or elastic plus-pressure are immediately wasted. The advantages and the disadvantages then of rotatory engines rest wholly upon considerations of a practical character.

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The advantages which are soundly based, chiefly resolve themselves into the fact that in this form if an engine could be produced, it would occasionally present considerable conveniences in enabling rotation to be directly communicated to a shaft for special objects. Thus, rotatory engines, if otherwise unobjectionable, would present great convenience for actuating twin screws in ships' launches, or for steam fire engines, or for certain forms of cranes, &c.; in all these the facility of rapid reversal being one object. Much stress has been laid by the inventors of this class of engine upon the alleged saving of weight in the machine in relation to its effective power, but in this respect the advantages has been overrated.

Practical disadvantages.

Apart then, from the main theoretic disadvantage already referred to, the disadvantages of rotatory engines also rest wholly on practical considerations, and these resolve themselves mainly into two. 1st, it has hitherto proved an insuperable difficulty to obtain any stop or fulcrum against which the steam can react in urging a piston round the axis within a cylinder or drum, which does not involve a shock or blow, more or less, at each displacement of such fulcrum, or does not involve as a consequence inequality of rotation 2nd, no rotatory engine has yet been devised that does not by construction tend to become more and more leaky, as between the bearing surfaces of the revolving piston or pistons and the interior of the drum.

Whatever may be the sectional form of the interior of the drum,—the very best in a mechanical point of view being that of a cylinder in which a rectangular piston revolves round one edge placed in the axis of the cylinder—by the very nature of things abrasion by friction or wear, varies from the centre to the circumference, where it is a maximum. The applied plane-surface ends, of the drum or cylinder, they tend rapidly to become cones, and rectangular piston to become trapezoidal, while all wear of the circumferentially applied edge of the piston tends directly to withdraw it from contract with the interior surface of the drum. These are practical evils, which, however they may be mitigated by ingenious and usually complicated arrangements of "packing," can never be removed.

There are other practical difficulties of a serious character involved in this class of engines which space forbids us here to enter upon further.

Exhibitors of rotatory engines.

Amongst the engines of this class exhibited at Paris the four following were the most remarkable. That of Pilliner and Hill, shown in the English department. This consists of two deeply toothed and engaged pistons revolving

in two intersecting drums. It is, in fact, nearly identical with Hornblower's, but presenting some special contrivances for attempting to meet the evils of leakage by abrasion above referred to. Two teeth in each wheel in opposite ends of a diameter are hollow, and a staunching plate is forced out from the groove in each by elastic action (springs of caoutchouc it is said; but the latter will not long withstand the effect of even 50 lbs. steam) against the internal circumference of the drum.

The central shaft bearings at the ends of the drum are adjustible so as to adjust for the *greater* wear at the lower side of the drum by the weights of the pistons or wheels, and the flat ends of the drum are provided with certain wedge-shaped plates, which, without opening the drum, can cause the internal end plates to press up against the ends of the revolving piston wheels. But these originally flat plates, as well as the originally flat ends of the piston wheels, both tend to become cones, with their apices opposed to each other; and what is there to keep staunch the pistons and drums at the right angle between the ends and the circumference.

This engine worked very smoothly at Paris, and without considerable leakage there; and it is but right to add that it was affirmed to have worked in a ropery for 14 months, making 550 revolutions per minute, without going out of order. A water meter and a rotatory pump, constructed as this engine, were shown near it. M. Ed. Scheutz of Stockholm, who received at London in 1862 honorable mention for his very ingenious arrangements of a rotatory engine, operating not within a cylindrical drum but one of the internal form of a frustrum of a cone, produced at Paris an elaborate design for further improvements upon that engine. He has come back to the cylindrical form of drum. This is single, and the piston within it has got four staunching plates at opposite ends of orthogonal diameters which are alternately pressed out against the interior circumference of the cylinder, or pressed in towards the centre by sliding over plates which are the steam fulcra.

M. Scheutz's mechanical details as to staunching at the ends are more masterly than those of any of his competitors, as he reduces the surfaces of contact to narrow annular surfaces; but, to the extent of their breadth, measured radially, the evil of conical wear still applies in full force. The other details of the engine cannot be explained without illustrations. They are designed with especial reference to the employment of these machines for ships steam launches, and are simple and efficient.

The other two rotatory engines exhibited were that of Mr.

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Behrens, shown at work by Mew, Dart, and Co., of New York, and that of Mr. Thompson, shown at work also in the British department.

Both these machines depend upon one common constructive principle; namely, that one piston becomes the fulcrum for the other. In Mr. Thompson's, two pistons upon independent but concentric axes are placed in one cylindric drum, and each of these pistons is constrained to revolve with unequal velocity at different periods of each revolution. The slower moving piston thus becomes for the time the fulcrum for the steam to act against in urging round the other. In Behren's by a very peculiar configuration of the pistons, such that at certain periods of the revolution the extremity of one piston sweeps past the surface of the other there cut into the form of its evolute, the one piston is the fulcrum to the other without need of the unequal or differential motion of rotation found in Mr. Thompson's.

In Mr. Thompson's engine this inequality of movement in the two pistons is secured by their being connected (externally to the drum) by a pair of elliptic spur wheels. When steam is laid on between the pistons they tend to move in opposite directions, but at first the piston B moves further than A, and as the speed of the latter increases that of the former diminishes.

If we call $\omega$ the angular velocity of the piston B; $\omega'$ that of the fly-wheel shaft which carries the elliptic wheels 2 and 3, $\omega''$ that of the piston A.

$r\ r'\ r''\ r'''$ the radii of primitive contact of the elliptic wheels respectively $a$ and $b$, the semi axis major and minor of those wheels. Then when the two pistons are at right angles to each other, we have

$$r = b \qquad r'' = b$$
$$r' = a \qquad r''' = a$$

Taking then a position, at an instant, in which the piston B has described an angle B from its first position; the shaft of the two intermediate ellipses an angle $\alpha$, and the piston A an angle A, then the radii of contact will be:

$$\left.\begin{aligned} r &= \frac{a\,b}{\sqrt{b^2 + (a^8 - b^2)\cos^2 \mathrm{B}}} \\ r' &= \frac{a\,b}{\sqrt{a^2 + (a^2 - b^2)\cos^2 \alpha}} \\ r'' &= \frac{a\,b}{\sqrt{b^2 + (a^2 - b^2)\cos^2 \alpha}} \\ r'' &= \frac{a\,b}{\sqrt{a^2 + (a^2 - b^2)\cos^2 \mathrm{A}}} \end{aligned}\right\} \text{I.}$$

and we have for relations

$$\left.\begin{aligned} r + r' &= a + b \\ r' + r''' &= a + b \end{aligned}\right\} \text{II.}$$

and between the angular velocities of the several axis the following relations:

$$\frac{\omega}{\omega'} = \frac{r}{r} \qquad \frac{\omega'}{\omega''} = \frac{r'''}{r''}$$

or

$$\omega'' = \omega \frac{r\, r''}{r'\, r'''} \qquad \text{III.}$$

from which expressions the angular velocities described by one piston, when that of the other is given, may be calculated.

On starting from the position above indicated, the ratio of their angular velocities is $\frac{b^2}{a^2}$

If the ratio of the axes of the primitive ellipses of the engaging toothed wheels is as 1 : 2. the rates of the angular velocities at starting is as 1 : 4. and equations I and II combined, afford the following:

$$\left.\begin{aligned} \frac{2}{\sqrt{1 + 3\cos^2 \mathrm{B}}} &= 3 - \frac{2}{\sqrt{4 - 3\cos^2 \alpha}} \\ \frac{2}{\sqrt{4 - 3\cos^2 \mathrm{A}}} &= 3 - \frac{2}{\sqrt{1 + 3\cos^2 \alpha}} \end{aligned}\right\} \text{IV.}$$

and by eliminating $\alpha$ in both equations we obtain a relation between A and B which admits of calculating the first angle, the second being given:

If $\omega'' = \omega$ then $r'\, r''' = r\, r''$

and as $r + r' = r'' + r''' = a + b$: so $r' = r''$

which corresponds to an angle $\alpha = 45°$

But this angle corresponds to two complimentary angles A and B, and on the hypothesis $\frac{b}{a} = \frac{1}{2}$ the equation IV. gives for the values of these corresponding to $\alpha = 45°$.

$$\mathrm{A} = 70°.\,40' \quad \mathrm{B} = 19°.\,20'$$

so that since starting the two pistons have separated through the angle

$$\mathrm{A} - \mathrm{B} = 51°.\,20'$$

Upon the data given for the engine which worked at the Exhibition, the ratio of the angular velocities of the pistons would vary between 1 and $\frac{9}{16}$.

A considerable amount of ingenuity was displayed in the arrangements for endeavouring to make the pistons of this engine steam tight, but we must be permitted to doubt their permanent efficacy. The rotation produced by the engine on

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a whole was not free from inequality, at whatever fast speed it was worked.

The capability of extremely rapid stoppage and reversal, by the movement of a single lever acting on the admission steam valve, was clearly shown.

Two engines of this construction are stated to have been fitted for working the rudders of two large ships at Glasgow, and with satisfactory results. It may, without much doubt, be affirmed that from the essentially bad properties of elliptic geared wheels engines of this construction never can be increased in magnitude beyond a very moderate size, without risk of breaking down.

Of the engine of Mr. Behrens it is impossible to describe the construction, unaided by several illustrations. It worked with great velocity and smoothness at Paris, and it introduces a new element, at least, into the difficult mechanical problem of making such engines steam tight in permanence.

The pistons being, so to say, solid blocks, moving within the osculating drums, and applying themselves by large surfaces to both the ends and the circumferences of the interior of the drums, it is alleged that by proper original fitting and the means of precise adjustment at all times, the pistons may be kept always running quite close to the drum, but never in absolute contact anywhere, and that thus leakage will be met by the capillary resistance which the steam must meet, in attempting to pass through the extremely thin but broad and prolonged interval between the surfaces of the pistons and drums. In principle this is quite correctly based; but we may be permitted to doubt how far, with engines doing actual work for any length of time, such nicety of adjustment can be always preserved.

Nothing exhibited at Paris can be said to have materially advanced the problem of direct rotative engines, the importance of a solution of which, has been by many much overrated.

The strange single-acting high-pressure engines of Hicks, of the United States, in which the plunger pistons, by the aid of certain perforations and passages in them, are made to perform the functions of their own valves, and Andrews' (of the United States) oscillating high-pressure engine, with a curved faced slide, formed as a segment of a cylinder described by a right line transverse to the steam cylinder by the oscillation of the latter, are both at present chiefly to be regarded as objects of curiosity. The latter engine actuates an American helicoidal centrifugal pump, the construction of which is peculiar, and deserves attentive consideration.

Locomobile engines.

The great mass of the locomobile engines exhibited are of average merit. They all evidence advancement in design, and more especially in workmanship, and indicate not only that a better skilled class of engineers are now engaged on those machines, but that better tools are in use for their production, than in 1862. There are many details in which improvements might, in a more comprehensive report, be noticed; but in general design there is little new. In the Swiss locomobiles are several, however, with the Allen engine valve-gear applied. The traction-engine of Albaret et Cie., of Paris, is in some points worthy of attention.

Parts of engines.

Amongst the parts or adjuncts of steam-engines shown which deserve notice, are the spring suspended ball or centrifugal governor, by Pickering, of the United States. It possesses the advantages claimed for the Porter governor, with simplicity and small cost. The injectors shown are numerous. That which appears to possess most merit and novelty is the injector of Schaeffer, of Magdeburg, which has the advantage of being constantly charged and ready to inject feed-water, and of being less capable of being put out of order by the careless handling of the adjustments of the central needle cone, than in previous constructions. Other simplifications of this important instrument are also exhibited by other makers.

Amongst parts of engines shown, the forgings of the Société Ansaldo, of Genoa, demand attention. It has not been hitherto commonly known that Italy could produce, amongst other excellent forgings, a wrought-iron shaft of 22 ft. long by 1 ft. 6 in. in diameter. Grease-cups, grease-cocks, valves, boiler and furnace gear in innumerable varieties, and in many instances of great merit, are exhibited, into which space forbids our entering.

Boiler apparatus.

The automatic feed-water apparatus and water-meter combined, for steam boilers of MM. Roufosse, Houget, and Teston, though a little costly and complex, is of much ingenuity, and appears capable of acting perfectly, and conferring additional safety on boilers.

Nor should we omit to notice the magnetic or electric-protection for preventing the attachment to boilers of hard deposit from the water, exhibited in the English department. As yet neither the efficacy of the proposed instrument is rendered certain, nor, admitting that, is its theory of action known, we may, therefore, until further information has been had, pass it without further remark.

Boilers.

The boiler, even in its best and most economic form, remains still the worst part of the steam-engine. Few boilers of actual size not at work are exhibited, but several models

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and designs for various combinations or forms ,more or less pretending to novelty, are to be found; and many forms of smoke prevention. None seem to demand (within the limits here prescribed) particular mention, unless it be the "Fumivore," apparatus of MM. Thierry et Fils. The action of their apparatus is effective, but its principle is not new. The more diffused application of the regenerative furnace of Siemens will hereafter render "smoke burning" a thing obsolete.

A remarkable *tour de force* in the way of boilersmith's work may be noticed as exhibited by Durenne, of Courbevoie near Paris: a vertical cylindrical boiler and vertical funnel, with two cylindrical transverse flues, at right angles to each other, and internal fire-box, all welded into one piece by hand. There are various other *tours de force* shown in this and in other allied classes of the Exhibition, which prove that foreign workmen at present can be found quite as able and adroit as any that Great Britain can produce.

Of the other motors belonging to this class we can mention here but the gas-engines, one of which claims to be an advance upon the Lenoir engine, inasmuch as by an arrangement of singular ingenuity, the ignition of the explosive mixture of coal gas and atmospheric air is effected at each half stroke of the piston by a gas jet always ignited and external to the cylinder, so that the use of any galvanic apparatus for ignition becomes unnecessary.

Gas engines.

Of caloric or heat engines, *i.e.*, those whose power depends upon the alternate expansion and contraction, or discharge, of a given volume and weight of air or other permanent gas, the most remarkable example exhibited is the engine of Mr. P. Shaw, of the United States. In this engine, which theoretically does not propose to effect more than has been previously done by others, some of the practical or mechanical difficulties hitherto attending all caloric engines appear to be greatly palliated, if not removed.

Turbines.

Several well-known forms of turbine are exhibited, as well as that for very high falls, by Rhieter, of Winterthur; and the singular floating water-wheels of Colladon, of Geneva. The improvements in turbines now necessarily move in the direction of simplification of parts, so as to cheapen the machine, and make it in its wearing parts more durable. Its principles and the methods for proportioning its parts are now well known through the labours of many, amongst whom Fourneyron (whose recent death in the midst of his labours at the Exhibition all deplore) will ever be viewed as having borne a most distinguished part. It is an unexpected fact to find that MM. Fossey and Co., of Lasarte, in Guipuscoa,

Spain, are amongst the largest makers of turbines in Europe. They produce a list giving particulars of above 120 turbines erected by them in that kingdom.

Windmills.

Amongst the motors dependent upon the motion of the wind may be mentioned the very simple and ingenious arrangement of windmill with moveable vanes, acted upon by a peculiar form of centrifugal governor, upon the "systeme Thirion," exhibited in the park by the Société Anonyme de Chatelineau, of Belgium.

There was also exhibited the highly ingenious and in principle well-devised horizontal windmill of Mr. Moerath, of Vienna. This is in fact an air turbine; its principle is the same with that of the vortex turbine of Mr. James Thompson, of Belfast, in which the water is admitted at the circumference, and passing the directrices escapes by a vacant aperture at the centre.

We had no means of ascertaining whether any experiments of a sufficient or trustworthy character had been made upon this windmill, to compare its "duty" or useful effect with that of the ordinary windmill with inclined sails. The arrangements of governors for the foreign windmills exhibited, showed great ability in their simplicity and effectiveness.

Steam cranes.

Amongst the apparatus destined for the elevation of solids numerous steam-cranes, fixed or moveable, are shown. None seem to possess very prominent merits of any sort.

The finest work of this class shown is the overhead or Gantry crane, by Cail and Co., employed upon the quay of the Seine for the landing of heavy pieces for the Exhibition. Amongst the designs for this class of machine is one, by Laulet and Co., of much merit, for a very good, cheap, and simple form of steam Gantry for quarry purposes.

There are very many hoists and lifts for warehouse, hotel, or other like use; some dependent upon chains and gear, others upon direct hydraulic support and lift for the entire elevation, which is here equal to that of the total height of the machinery zone of the building. These lifts, as exhibited at Paris, are rather toys for popular amusement than objects of interest, for their novelty or merits to the mechanical engineer.

Pumps.

In the fourth group of our division of this class the pumps exhibited are almost innumerable, and of every class, from the smallest and commonest domestic pump to the large machine for supply of towns, drainage, or irrigation.

Centrifugal pumps present little beyond the old models seen in 1862, and often besides. The American centrifugal pump, already noticed, is an exception, however; as is also a

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centrifugal pump in the Swiss annexe, in which the central box of the revolving central piece is so made as materially to reduce the hydraulic coefficient of contraction of the vein of fluid entering the "ears" of the pump at each side. Mr. Bernay's, of London, construction also aims well at these advantages.

Bastier's chain pump is shown at work. In construction it is not new. It is much to be regretted that upon the present occasion, just as in 1862 and 1855, there is no organisation by which the actual duty of the more prominent of these pumps, and more especially of the centrifugal pumps, can be experimentally tested. Such trials would add some valuable and much-wanted data to practical hydraulics, and would strip away much false pretension, which at present only requires bold utterance to have its effect with the public, and to pass uncontradicted even by the man of science, who feels he is not in a position to give any exact judgment. But this would apply to much more besides in such exhibitions as these.

Fire-engines.

To this group belong fire-engines. Manual fire-engines prove the wide extension they have within the last 10 or 15 years obtained all over the world, by the number of exhibitors from nearly every state of Europe. Most of these foreign manual engines are neatly turned out of hand, and dignified with much polished brass, paint, gilding, and varnish. But the forms are never as good as those of our best English engines, and in some cases the fundamental principles upon which the power of men can alone be to the best advantage applied to a reciprocating handle of a fire-engine appear to be unknown. Some of the smaller French bath or pan fire-engines may probably possess advantages, in relation to the structure of the buildings in the older towns of France, and to their water supplies, that are not apparent to us. Austria shows fire-engines with plate-iron cisterns, and in tolerably good proportion, such fire-engines, wholly of iron (except the handles) have, however, been constructed in Great Britain and Ireland 15 years ago.

Several steam fire-engines are exhibited, amongst the chief of which are those from England by Merryweather and Sons, and by Shand and Mason, and one by Goldschmidt, a French maker. These were tried in contest at the Seine Quay, when, after a protracted and well-fought trial, the engines of Merryweather and Sons were declared by the jury the best. Did space permit, we should be prepared to point out good grounds to justify that decision, as regards both the design and the performance of those engines.

The archæological student, as well as the mechanical engineer and tropical agriculturist, will examine with interest the photographs by M. Desiré, of Cairo (Egypt), of the ancient apparatus and methods of irrigation, which have latterly been supplanted by steam-pumping in Upper Egypt.

Air-pumps.

We may include in this group, machines for the pumping of air. Of centrifugal fans there are innumerable examples, none presenting wide or important departures from known models. The application of a fan under peculiar conditions to supplying blast to a smith's hearth in such a way as to pass back some of the unconsumed gases of the fire with the air through the incandescent fuel, by Rhieter of Winterthur, is worthy of examination, and, were it here practicable, of trial.

Of machines for the transfer of condensed air in large volumes for manufacturing uses, the largest example is the blast-engine shown by the Société Cockerell, of Liège. This is a vertical machine, with the large blast-cylinder standing on the top of the lofty framing of the direct-acting double-cylinder engine beneath it. In the design of the cylinders and nozzles of the engine itself are some points of merit; but the general design of this work, though stated to be similar to that by which the Cockerell Company have constructed a large number of blast-engines, is such as it is impossible to refer to favourably.

Various machines and parts of machines.

Amongst machines for moving great volumes of air without any considerable condensation of volume, is the mine ventilator exhibited by the Bochum Iron and Steel Company of Prussia. There are many other ventilators exhibited.

In the fifth group it is impossible to notice here more than a mere fragment of the numerous objects exhibited, which, on some ground or other would deserve particularisation

By far the most important and interesting is an automatic weighing-machine for grain-seeds or any other material divided into particles of such a nature and size as to run trough tubes or apertures, in the same way the above substances are known to do.

The grain or other material, descending along an inclined tube, is constantly discharged into one or other of two coffers, which are equilibrated each upon an axis in such a way that the instant one is filled by the running stream of grain, to a given bulk, it cants over and discharges, and returns directly to its place to be filled again, and so by the other coffer alternately.

The axis of each coffer is borne upon one extremity of the levers of a weigh-bridge or compound balance; and this is so

adjusted that, when it is pressed down by a given weight (namely, that of the full of the coffer of the substances being weighed), but not before, it at the same time releases a detent, which permits the coffer to cant, and at the same time registers the fact (upon a counter) that it has canted, *i.e.*, that one coffer full has been weighed, and so on continuously. The exactitude of the machine seems as great as can be desired, and its action perfect. It could be applied upon almost any scale, so that cartloads of road metal or of paving stones or cannon shot might be thus weighed as well as mustard seed.

Mr. Rabo, of Guastalla, Italy, also exhibits arrangements for mechanical weighing of grain. The decimal balances of Tengelin, of Stockholm, and of Butenop, of Moscow, as tending to abridge labour, are worthy of observation. Amongst this class of machines we must not omit notice of the admirable weigh-bridge (*bascule*) of M. Taurines, which, though capable of sustaining and giving accurately the weight of a man, is of such exquisite delicacy that, when standing upon its platform and perfectly still, the difference between the impulse of the current of blood discharged upward by the heart, or above its own level, and that sent downwards, is seen distinctly to cause the index to vibrate synchronously with each beat of the pulse. These beautiful machines are, nevertheless, less complex, more durable, and as cheap as the ordinary weighing machines such as we see commonly at railway stations, &c.

Mechanical apparatus for the measurement of liquids, in the shape of water meters, are numerous, and many of interest, while some few have received the sanction of considerable practical adoption by water companies, &c.

The Fabrique de Landquart, of Switzerland, exhibits good arrangements for measuring mechanically liquids employed in commerce, &c. By far the most interesting and ingenious instrument exhibited of this class, however, is the alcohol meter of Messrs. Siemens; an instrument destined, not only to determine and register the volume of spirit passed through it, but to determine also the amount of absolute alcohol which it contains.

The gasmeters, both British and foreign, are exhibited in great numbers, and are nearly all of great average, and some of very high merit. It would exceed much our space, however, to go into the details of these, which would involve much explanation, scarcely possible without illustrations to make them intelligible.

The steam pressing or forging machine of Mr. Hassal, as

exhibited by Egels, in the Austrian division, was placed in this class, though more properly belonging to that of machine tools. It is matter for regret that this tool, destined hereafter to play a great part in the working of iron, as well as of other malleable metals, was not shown at actual work. The general arrangements, by which a prodigious *pressure*, obtained through the medium of the hydraulic press, is made the substitute for the *blows* of the steam hammer, will be tolerably obvious on inspection of the machine. To explain its full value as a tool for working into new forms wrought iron at high temperatures would involve much introductory remark in relation to the molecular properties of metals. The pressure forging machine will hereafter enable wrought iron to be given forms by the aid of hollow dies or swages, which are impossible by the percussive action of the steam hammer, and so to extend the wide domain of existing uses of forged iron in structures, such as iron ships, engine framing and their parts, artillery, &c.

Amongst the organs or parts of machines exhibited, few were of greater merit than Herr O. Beylich's two-wheeled and three-wheeled central coupling or clutch: of this two forms were shown. These couplings can be made to perform all the functions of the Hook's universal joint, along with the transmission of motion by gearing, and the combination is one which will often prove of value, especially to the millwright and tool-maker.

Some of the various arrangements by which the shafting at work in the great machinery zone was changed in angle to suit the curved form of the building while the rotation was preserved, were of much merit; but, as being machinery in motion, the description of them belongs to another class.

Amongst other objects intended to constitute the organs or parts of machines, the toothed wheels exhibited by Piat and Co. (France), which are cast without the use of wood models, by the aid of moulding machinery, deserve the highest commendation, and the careful observation of every ironfounder. The forms of the teeth of all those various sorts and different sizes of toothed gear are excellent, and the mutual adaptation of these in wheels and pinions, whether bevel or spur, in endless screws and worm wheels, &c., perfect; but the perfection of execution of the castings themselves is still more remarkable, and, indeed, can scarcely be exceeded.

Leather belts also, as organs of machines, are widely exhibited, and shown in great perfection and in the very largest sizes. Those of Scellost (France), of the very

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largest size and thickness, for the tranfer of the whole power of first movers, formed of leather and wire woven together, the integrant straps being placed on edge, are worthy of the attentive examination of the mechanician.

Telodynamic invention of M. Hirn.

No more remarkable, nor, probably, as regards its future, more important object is exhibited on this occasion, than is the arrangement of M. Hirn for the transfer to great distances of power and motion by the rapid transfer of an endless wire of small diameter over large and peculiarly-constructed pulleys, one of which is at the transmitting and the other at the receiving end of the telodynamic range. At first sight, or to the casual observer, M. Hirn's arrangement, which was without interruption at work in the park, where it transmitted through a wire not thicker than a large pencil about 25-horse power (nominal), to actuate pumps (supplying the building) at a distance from the source of power of several hundred feet, appears but one form of the old well-known strap or belt, with its strap pulleys; and it *is* so much, but it is also much more, for it involves and is based upon a *principle* which had not before been made available for the transmission of power to great distances.

This may be popularly stated thus:—When work, that is, pressure and motion together, has to be transmitted by tension through a cord or fibre, such as a wire or rod of iron, or other material, a given amount of work in a unit of time can be always transmitted through a smaller and smaller section of fibre or rod in proportion as we increase the velocity with which a point in the transmitting fibre or rod travels; so that the product of the pressure and of the velocity with which it acts to produce work shall be constant. For example, a cylindrical bar of iron of 1 in. diameter, we we may say, can transmit a pull of 10 tons through itself without stretching; and if, that pull being always on the rod, a point in its length passes a given fixed point at the rate, let us say, of 5 ft. per second, then at that point the rod is transmitting work at the rate of 10 tons × 5 ft., = 50-foot tons per second.

But if we have another rod of the same material, of only one-tenth of an inch in diameter, which will therefore have 1-100th the cross section of the 1-in. bar; this will bear, without stretching permanently, the 1-100th of 10 tons, or 1-10th of a ton. Now, if this last rod transmits this pressure of 1-10th of a ton past a given fixed point at a rate one hundred times as fast as in the former instance, then the work transmitted by the small and the great rod shall be equal in equal time. Or—

1-in. bar, 10 tons × 5 ft. = 50-foot tons.
1-10th-in. bar, 1-10 ton × 5 ft. × 100 = 50-foot tons.

But this last is a mere wire, and will be light and flexible enough to be passed round the rims of large pulleys at such high speed, and by friction on these rims (friction for equal pressures being the same at all velocities within large limits) to transfer the work to their axes in way of rotation. Thus, theoretically, the power of the largest steam-engine in the world might be transmitted to any distance through a human hair. The practical limit with steel wire is found, however, about where the diameter is reduced to from two to three tenths of an inch. The limit of velocity is only that at which by centrifugal force or want of perfect balance the pulleys might become deranged or unsafe.

M. Hirn has, by this beautiful and simple adaptation in practice of a dynamic principle, succeeded in transmitting the power which drives large factories to great distances; in some cases as far as across the Rhine near Schaffhausen.

Progress since 1862.

In general, the objects exhibited of every group into which we have (for the purposes of this report) divided class 53 indicate to the skilled observer more exact knowledge and more heedful adaptation of *principles* upon the part of constructors than in 1862.

There is also obvious an almost universally advanced standard of execution, owing to improved manual skill, but far more to improved and better adapted and often special machine tools.

The class can scarcely be said to be characterised by any one great novelty, or by any invention not before exhibited, and likely to mark an epoch in future industrial history.

The great lesson to be learnt from the examination of this as of several other classes in the Exhibition of 1867, and which it is important for all Englishmen to ponder upon, may be expressed in the very same words in which the reporter expressed his conclusions upon the class of prime movers exhibited in London in 1862.

Need of technical instruction in Great Britain.

"It is not to be concealed, however, that the advances made by us in Great Britain, during the past decade, have not been commensurate to those achieved abroad. France, Prussia, Belgium, and America are now, and in the order named, fairly 'our rivals' in this that we have been wont fondly to suppose was our national specialty and peculiar apostleship. France, in her superior system of technical education for her working men, with the sound and thorough science of her technical professors and leading engineers; Prussia, with her own well-founded system of bread knowledge education, for her work-

ing classes, their sober and thrifty habits, all bid us beware lest in this great race the tortoise beat the hare at last."

That which was thus true in 1862 is far more widely and thoroughly true in 1867, and, as has lately been well said, "so sure as knowledge is power," whether to individual or nation, and the want of it weakness, so had we best bestir ourselves mightily and promptly in Great Britain lest this shall be no longer true with respect to us 10 years hence.

## Report on Machine Tools.—(Class 54.)—By J. Anderson, Esq., C.E.

Mr. Anderson on Machine Tools.

Class 54 contains the various descriptions of machine tools that are employed in the working of wood and the metals generally, more especially the working plant of the mechanical engineer, such as lathes, planing machines, and other instruments by which form and precision are given to works of construction. Class 54, machine tools.

In this department of practical science Britain has hitherto been pre-eminently the leading country. At the Great Exhibition of 1851 it may be said to have been without a rival; the display of machine tools then made by some English houses took the world by surprise. The French and German, and even the American engineers were not prepared for such refinement of form combined with solidity of construction, the several fittings having a degree of precision never seen before, and yet constructed with such severe simplicity of arrangement in every detail, which by general consent placed England above comparison with the rest of the world. British pre-eminence in 1851.

The effect of that display immediately told, not only upon the machinists of other countries, but likewise on our own of second and third degree; and by the arrival of the Paris Exhibition of 1855, it was at once perceptible that a great change had taken place. Then, for the first time, a symptom of rivalry on the part of both France and Germany was visible; but still more remarkable was the general improvement in the productions of some of the English houses, resulting from the high standard of tool-making set up by Whitworth and others in 1851. The slender forms of construction of former times began to disappear and to be replaced with the sounder and more graceful outlines of hollow framing which are now so general. The change perceptible in 1855.

There was a great movement between 1855 and 1862 in regard to this class of machinery, not only in Britain, but all the world over. In Britain an immense effort was made by many of the leading firms, and when the Exhibition opened the great advance made was apparent. This advance did not consist so much in new invention as in the progress of the second class towards the point reached at previous exhibitions by those of the first class; neverthe- The advance shown in 1862.

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less, there was still, to the close observer, a great difference in the style, fitting, and general finish of the various houses and, as a rule, the highest of 1851 carried off the palm in 1862. But the notable feature of 1862 was the marked progress of other countries, especially in France, Prussia, and America.

Britain not properly represented in 1867.

When the Exhibition of 1867 was contemplated, the several countries looked at the competition from different points of view. Britain, conscious of former victory, was lethargic; the majority of houses were tired of the unremunerative expense of former exhibitions; and hence it is that this country has not come out in proportion to the extent of her industry, and but for the circumstance that a few of the best makers have come forward, Great Britain would have been unrepresented. On the other hand, the variety and number of tools exposed by France and Germany is enormous, and out of proportion to the extent of their manufacture of these articles. At the same time, the strong family likeness which the greater number present to the best English tools is a most striking feature; the same remark also applies to ourselves, for it must be confessed that real excellence, the power of real advancement, does not belong to nations but to individuals. During the last thirty years the great strides have been made by a few men; their arrangements and forms have been repeatedly copied and put under so many transformations that the world really forgets the origin, and comes to give any maker who may have about him sufficiently skilled draughtsmen or workmen the credit which belongs only to the original; but a more healthy tone is spreading, and the time is fast approaching when to use other men's forms or mechanical arrangements will be looked upon as we now do on plagiarism.

French tools in 1867.

Even the French, who are usually so prolific in invention, have mistrusted themselves in this department. In regard to steam-engines, their ingenuity has run wild in the variety of their designs, arrangements, and combinations; but in the matter of machine tools it is otherwise. In 1862 they were impressed with the grand simplicity and solidity of the English tools as compared with their own, and in their laudable desire to excel on this occasion they have rather overdone many of their machines in these particulars; yet it must be confessed that, notwithstanding many glaring defects, their display upon the whole is magnificent, whether prompted by individual or from patriotic motives; and, judging by their efforts in the matter of steam-engines, we have

every reason to expect that when the toolmakers of this nation feel themselves on an equality with England they will give over imitation and strike out into the boundless region of mechanical combination which lies open to us all.

German tools, 1867.

The display of tools from Germany is also grand; upon the whole, they are fully equal to the French and almost equal to best English. So far as design is concerned, they are as a rule strictly English, although there are many exceptions.

It is not, however, in the departments of France or Germany that the English tool student will find the greatest treat; in the machines from those countries there are many familiar forms and arrangements, beside much that will disappoint him, such as scraping for mere ornament instead of for surface, the marks being arranged in squares or diamonds by way of a pattern as in calico-printing, he will find additions to machines put on in another character from the order or style of the original machine, and with the fitting barely up to the Whitworth standard; hence the lesson which is taught is more of a commercial than of a scientific character.

American tools, 1867.

In America, on the other hand, he will find something new; not only exquisite workmanship of the highest class, but new combinations even in connection with such a stereotyped article as a turning-lathe or a planing-machine, and without the loss of any of the essential points secured by English models.

Such a visit in the proper spirit will serve to show the necessity of fresh thinking on the part of our young toolmakers; it will stimulate to a closer search for better combinations, and thus may they expect to hold the place achieved by their fathers.

## France.

France having the most extensive display of tools in this Exhibition, and being first in the general catalogue, it will be convenient to commence with that department, and in the order which they occupy in the building.

French section of machine tools for wood and metal.

Deny, of Paris (36), has made a moderately good show of small tools, especially for cutting plate-iron by means of circular shears; likewise a convenient mode of working the ordinary screw fly-press by steam-power instead of by hand. Although neither of these appliances is new, still they are not so much appreciated in England as they ought to be. In working the fly-press, a band of leather is attached to the outer edge of the fly-wheel on the top of

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the screw; immediately over is placed a shaft with two discs almost touching the outer and opposite edges of the leather; by means of a handle with a lever the disc shaft is pushed on one side or the other, thus imparting motion to the fly-wheel accordingly in the required direction.

Lathes and other tools.

Ducommun, of Mulhouse (29), has a fine show of machine tools, mostly in the English style; lathes, large and small; planing, slotting, and drilling machines; and, upon the whole, the workmanship is very good, although not uniformly so. Their large lathe, if not the best in the Exhibition, is a grand tool, which has been carefully worked out in most of its arrangements, and the workmanship in some of its details is exquisite. The arrangement for disengaging the back gear is very perfect, the teeth of the worm-wheels being cut out of the solid metal in a very superior style, and with the worm fitting into the teeth in a manner which we seldom see; on the other hand, the details of the V frame in the middle of the bed of this large lathe, although convenient, are not in keeping with the general design, and the position of the gap in the break lathe is evidently in the wrong place. The large drilling-machine is of doubtful proportion; but, notwithstanding all this, the several tools are of a high order,—good, sound, honest articles, and superior to any French tools of a few years ago.

Band saw.

Périn (1), of Paris, makes a good show of machines chiefly in connection with the treatment of wood. It was Périn who brought out the endless band saw in 1855; he is still the largest exhibitor of such articles. Some of his machines are of large dimensions, with a saw nearly 3 in. board; but the greatest triumph of the band saw is from England, by the Secretary of State for War, from the Royal Carriage Department at Woolwich, by showing that Périn's saw is equally applicable to metal. The most of Périn's boring tools and sawing-machines are worth careful examination; but the latter have been developed in so many different ways by other makers that it becomes difficult for the inventor to keep pace with the world.

Tools for wood.

Santreuil (30) has some good machines for working in wood, especially one for mouldings, in which the undercutting is very fine. Some of the products of these machines are so perfect as to fully warrant the most conservative builder in discarding the old tools.

Saw frame for ship work.

Normand, of Havre (34), shows a simple arrangement of vertical saw-frame, intended to cut the ribs of wooden ships; it is capable of cutting on the skew or curve as

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easily as in straight lines. This machine, although rudely made, is thoroughly practical and well thought out in its details, and uncommonly convenient for the purpose intended, as performed by men who may not be expected to have much skill for more refined arrangements. This tool is worth the attention of shipwrights who still employ hand tools; but, as a whole, it is inferior to the band saw.

Machines for hand working.

Sculfort, Malliar, and Meurice (43) exhibit a collection of machines intended apparently for engineers in a small way of business. The most of them are contrived for working by hand, and are more in the old French style than in accordance with modern notions. An examination will show the change which is taking place.

Drilling machines.

Duval, of Paris (53), have a few engineers' tools with some good points, yet without any special advantages; their drilling machines are placed upon the top of a column, which certainly does not improve their appearance or add to their stability.

Hand lever punching.

Lecacheux, of Paris (40), displays a few simple hand machines, chiefly for clipping and punching iron; they have the lever combination so well arranged as to surprise some at the shearing result which can be accomplished by exerting a small pressure upon a lever over a long distance.

Boot-heel machine.

Enodeau, of Paris (41), have two very simple machines of the lathe class for producing the very peculiarly shaped heel of the modern Parisian ladies' boot. They are a good deal after the Blanchard arrangement of lathe, and produce the required article cheaply and quickly.

Drilling and slotting combined.

Messmer, of Graffenstaden Works (60), has a grand display of engineers' machine tools, some of them magnificent in design and proportions. Their chief machine, and one of the most remarkable tools in the Exhibition, is that for drilling and slotting the wrought-iron framing for locomotive engines: it is deserving of careful study, and will be found to contain many good points, as well as some defects; but no one can fail to be pleased with it as a whole, and to feel that the time has arrived when we shall have formidable rivals to compete with. Machines of the same character have been made in England by Smith, Beacock, and Tannett, of Leeds, and by others, which in some of the arrangements of gearing were even superior; for when the saddles of this machine are brought to the driving side, the overhanging portion of the shafts must be objectionable, besides the room which is wasted. A machine of this high character may well bear criticism,

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for, as a whole, it is probably not to be matched by any machine of the kind in the world. A slotting-machine, arranged for cutting the teeth of wheels by the slotting tool, is rather doubtful, when considered from an economical point of view. This machine does not come up to the high standard of the grand tool, either in its proportions or disposition of the metal, especially in the back parts of the framing, where it is clumsy, which is the more surprising, as they have alongside a smaller machine of the same nature, which is almost faultless in its harmony of form and proportion.

Heavy tools.

Bonhey, of Paris (62), makes a great display of large, massive, heavy tools. They are not so finely constructed, nor are they beautiful in outline; but they are strong and serviceable, and may suit many branches of trade in France, as we see the same class of tools extensively made on the other side of the channel and find a large market. One remarkable machine for shearing and punching is provided with four instruments—one at each end, as usual, with two additional tools introduced in the middle. The merits of the arrangement have been freely discussed in regard to the economical advantage as compared with two distinct machines; still, it is well deserving of close scrutiny, for future guidance.

The Ocean Company (No. 7) make a most imposing show, and the greater number are first-class tools, difficult to surpass; others, again, such as lathes, are inferior to those from the best English houses. Two machines for vertical planing are especially deserving attention. One of them

Vertical planing and boring.

has a vertical stroke of 14 feet, and is provided with a small steam-engine, placed on the rear of the framing; the whole combination being well arranged, and the workmanship quite up the present times. They also exhibit a boring-machine, which, like the vertical planers, has quite a character of its own; it is driven by worm gear, and is sound and good in all respects. Their radial drilling-machine is not so remarkable; indeed, there are trifling points which might be modified with advantage to the future proprietor. It is surprising how many of the radial drills in the Exhibition have not been sufficiently thought out in their details to enable the drill to be brought to the centre point without the operator having to remove his eyes or change his position to make the adjustment.

Gun-barrel machinery.

The Imperial Manufacture of Arms (64) exhibits an assortment of machines for drilling and rifling steel gun-barrels, and for other purposes connected with the manu-

facture of small-arms. The whole plant is simple and well designed for the work intended, and will prove good serviceable machines; but they contain no points of improvement in advance of similar machines used in England.

France.

Cail and Co. (32) show a lathe and drilling-machine, both passable tools, but without remarkable points requiring special notice. Ordinary tools.

Varrall, Elwell, and Poulot (59) exhibit an extensive collection of engineers' tools, mostly after the English style. This firm is celebrated in France for the best materials and workmanship. After hearing so much, the first impression on seeing their larger tools is slightly disappointing, not so much in regard to their soundness or efficiency as working tools, but rather in the appearance of the heavier parts. Considered merely as castings, many of them appear to have been moulded in loam, and that the mould had been fashioned a good deal by the hand of the moulder. The surfaces are slovenly in appearance, which detracts greatly from the beauty of the machine, and does not afford that pleasure which is derived when beholding the more graceful outlines of many other machines in this Exhibition. One of the machines exhibited is a large and massive punching and shearing machine, much in the style of De Bergue. It contains four instruments—two horizontal punches and two angle-iron shearers. Altogether, it is a good specimen; and the more important parts are executed with unexceptionable workmanship. They also show a well-constructed steam-hammer, on the Naylor plan; but with all the good and bad points of that system. Their slotting-machine is well constructed; the breadth of the tool holding part of the slotting-bar is perhaps an exception. This peculiarity distinguishes a considerable number of the continental slotting-machines. It has one advantage; for, admitting that it gives a defective twist when a single tool is used upon one of the edges, yet the great length of the slotting-bar more than compensates, while the breadth affords greater facility for the simultaneous operation of two or more cutting-tools. The lathes shown by this firm are about the best in the French department. Upon one of their lathe-beds is placed transversely a pair of headstocks for operation with milling or other tools at right angles, no doubt intended for some special purpose; indeed, the introduction of special tools is a remarkable feature all through the foreign department of the Exhibition, more especially chucks, angle-plates for every conceivable kind of fastening, and many other similar conveniences. They exhibit a remark- Steam hammers and other tools.

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ably good drilling-machine for the boring of shell; this tool has been well-considered throughout, and will bear any amount of scrutiny. They also show a shaping-machine, which is uncommonly well made; it contains the best points of the best machines as made by English houses. The power is applied direct to the shaping-bar, a point frequently neglected, to the manifest disadvantage of many machines of this class. The form of the teeth of wheels, as made by this and other French firms, is worth special notice. This is partly due, no doubt, to the great diffusion of mathematical and scientific education in that country. Such knowledge fosters a love for these refinements, and at the same time gives the power to develop them, and secures for any nation possessing it a higher vantage-ground for the battle of industrial life.

The French display as a whole.

Taken altogether, the French display is remarkable; and, remembering their position in 1851, and even in 1862, and now beholding the wonderful progress which has since been made, we may rest assured that, beside school learning, the people have great aptitude for mechanical pursuits, and are most skilful as handicraftsmen in every description of smithing and the working of metals.

Creusot collection.

Should any doubt exists in regard to the position attained by France, a visit to the collection of Schneider, of Creusot (113), is recommended. It is contained in a building in front of the French machinery annexe; there will be seen the largest display of machinery ever made by a single firm—steam-engines of all descriptions, an engineering tool of the highest class, smithwork of which any nation may be proud, and samples of iron which, for malleability, is so far superior to anything which we are accustomed to handle as must suggest painful misgivings in every patriotic mind.

Belgium.

## Belgium.

Machine tools.

Although Belgium comes out in great force with regard to steam-engines and other machinery, yet the display made in machine tools is limited in number, and those exhibited are certainly not of the highest quality. As a rule, they are inferior to the productions both of France and Germany. The chief exhibitor is the firm of Cail, Halot, and Co. (1); but even their productions are not of a high type. Comparatively little originality is displayed in their construction, and the workmanship is scarcely beyond the range where surface scraping is resorted to for ornament. There is a large market for tools of this nature,

and possibly they may meet the present requirements of their customers. One of their machines for planing the edges of boiler or other plates is well designed, and all their other tools are good, serviceable articles, well adapted for the ordinary work of an engineer.

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Belgium.

Planing edges of boiler plates.

Fétu and Deliége, of Liège (4), exhibit a few tools, mostly of the common type; it will be observed that the toothed gear has been cut out of the solid, and the workmanship altogether is of fair quality.

Teeth of wheels.

Steam hammers.

The firm of Detombay show two good steam-hammers. The framing of the larger one is a grand specimen of design and casting, and is similar in arrangement to that of a 12-ton hammer made by Mr. Wilson, of Patricroft, for the Royal Arsenal a few years ago.

Large lathe.

By a visit to the Belgium annexe another opportunity will be afforded of examining the progress of tool-making in this country. Those exhibited in the annexe are moderately good, rather too light in structure, and the spindle of the large lathe rather too small in diameter; still they are good honest tools; and, taking them altogether, they belong to the average of 1855, and inferior to the best tools of the present year, though superior to the majority of the Belgian tools.

Pipe casting.

A visit to this annexe will be well repaid by seeing a marvellous specimen of casting, the sight of which ought to make our founders reflect. The article in question is simply a cast-iron pipe lying in the corner beside the lathes above referred to; but this pipe is 20 ft. long, 28 in. in diameter, and varies from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. thick throughout; it is said to have been proved to five atmospheres, and can be sold at the same price per cwt. as pipes of smaller sizes and of the ordinary character.

Germany.

### Prussia and the Northern States of Germany.

Machine for cutting the teeth of large wheels.

From the display of machine tools made by some of the German houses in the Exhibition of 1862, it was anticipated that a great effort would be made for the present Exhibition; but the display which is made, both in regard to quality and quantity, is far beyond the most sanguine expectations; and, whatever may be the explanation of the rapid progress made in this kind of machinery, both in France and Germany, the fact remains for our information.

Zimmermann, of Chemnitz (11), exhibits a grand collection of machine tools, both for the working of wood and metal; one in particular, for shaping the teeth of large wheels, both spur and bevil, has deservedly attracted great

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attention for its perfect adaptation to the precise fulfilment of the object intended, and is quite a study in itself; although not an original design (a similar machine having been made by Shepherd, Hill, and Co., a few years ago), still it is a good specimen of tool-making. In the formation of the various curves of the teeth the form is produced from a perfect copy, which, by the mechanism, is correctly transferred to every tooth in the wheel to be operated upon in succession; the surface of a bevilled tooth being made up of various curves finely shading into each other, the mode of transferring such a recondite figure is admirably carried out—all the motions are concentrated for transfer upon the end of a hemispherical fixture. This machine is self-acting in most respects, even to the depth of the tooth; but it is not perfectly automatous, and so requires attendance. It is, however, well deserving of, and will repay the attention of, the millwright and tool-making student. Many object to its want of compactness and for not serving as a lathe to turn the wheels; still it is an admirable tool, which any maker may be proud of.

Quick return motion.

The means employed for giving a quick return motion to the planing-tool of a shaping-machine, by means of a double set of eccentric wheels working in unison, is well carried out; they seem to act very satisfactorily, and without a catch, as might be expected.

The nut-shaping machine is also very simple and neat, and will be difficult to improve upon. Likewise a machine for planing wood mouldings, another machine for curved mouldings, and a wood-planing machine, are all very superior, and leave little to be desired by the builder or carpenter. They also show a small jigger saw, in which the saw is turned about by the feet of the attendant in a simple manner. This tool is likely to be extensively adopted by builders of railway stations, or others who have much to do in ornamental fringe sawing. M. Zimmermann also shows the mode of grinding cutting-instruments which he has adopted. The tool, instead of being held by the workman, is held to the grindstone by an iron hand at the proper angle.

Saw turning.

Abuse of surface scraping.

Altogether, this display is of a very high class and accompanied with great refinement, while the defects are not nearly so conspicuous as in many of the continential houses; although in some instances scraping has been performed for ornament, which would detract greatly from their value in the English market.

Germany.

Hartmann, of Chemnitz (10), shows some fine tools of the largest class—a lathe for turning railway wheels, a beautiful slotting-machine, and a shaping machine, probably the largest in the whole Exhibition. This display cannot fail to teach us, as a nation, that from henceforth we can no longer reckon on the trade in tools as our own inheritance; indifference on the part of masters, or a few more strikes on the part of workmen, may easily divert the current from the old channel.

Tools, grand and massive.

Sigl, of Berlin (1), exhibits a fine collection of machine tools and other machinery, all of very superior design and construction. One from Britain, acquainted with English tools, while seeing a great deal to remind him of old friends at home, must also allow that much originality of form, and even of arrangement, has been displayed in many of the machines exhibited by this house. At the same time, there are but few remarkable points of distinction that require special mention.

Resemblance to the English style.

Wagner and Co. (2) show some tools of inferior quality, more especially in regard to workmanship; for example, observe the scraping in the cross slide of the planing-machine; it is throughout damaged so deeply as to require being re-planed, yet, no doubt it has been done by way of ornament.

Workmanship.

Collet and Englehardt, of Hesse (1), make a large display of machine tools, mostly very good, and some of superior quality; in some, however, such as the slotting-machine, the partiality for Manchester is too conspicuous; a firm with the capabilities they possess might safely rely upon their own resources. The self-acting lathe is not much admired, being too complicated and inferior in arrangement to many other lathes in this Exhibition; the workmanship, however, is very fair throughout, although not equal to the best of either France or Germany.

Tools, various.

Schmaltz, of Offenbach, have some good machines for working in wood, especially one for cutting mouldings; but none contain any remarkable points for the student, with the exception of a simple machine for rebating and joining pieces of wood of any figure—hexagonal, rectangular, or, indeed, of any geometrical form. The dividing arrangement is similar to that of a nut-shaping machine, and for this purpose is all that can be desired.

Machines for working wood.

In the department of the grand duchy of Hesse there is a most interesting and instructive collection of models of mechanical motions and movements, and also the necessary apparatus to explain every detail of machinery and

Models of mechanical motions.

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Germany.

engineering, beside models to illustrate the mode of constructing patterns for the foundry. The above is, probably, the most perfect collection ever shown; the prices quoted are fair and reasonable, and the whole display is worth the attention of all who are connected with the instruction of young engineers.

Novel gearing.

Professor Beylich, of Bavaria, in Class 53, exhibits two very ingenious and original combinations of cog-wheel gearing for the transmission of motion, which afford great facilities for the changing of direction without any disturbance of the mechanism beyond the actual performance. The tool-student should carefully examine these wheels with the view of turning them to account at some future day, for as yet they have had no practical application; a probable outlet for them will be in connexion with tools requiring continuous motion under varying conditions and circumstances.

## Baden.

Engineers' tools.

Geschwind and Zimmermann, of Carlsruhe (1), make an admirable show of engineers' tools, good forms prevailing in almost all. The workmanship is about the average quality, but there are few, if any, original points; notwithstanding, they are beautiful specimens, and, as a whole, are good, sound, honest tools.

Austria.

## Austria.

Although Austria does not make any great pretension at this Exhibition as a machine-producing country, still there are some very fair specimens of tools exhibited, which, as in other countries, may yet develop to greater proportions.

Dovetailing and other machines.

Ganz, of Hungary, exhibits a dovetailing-machine for cabinet or other work, which performs its duty very satisfactorily. With a little more thought spent over its details, this tool could be simplified and improved into an efficient practical machine. They also show a very good machine, on the American type, for boring railway wheels, A true surface, the shape of the rim of the wheel, is placed under a vertical boring apparatus; the wheel is simply laid in and fixed; it takes its place truly by the outside surface, and is bored in accordance. This, of necessity, implies absolute truth in the relation of the bed to the cutting instrument.

Wheel cutting.

Shultz, of Vienna, has a fair sample of a machine for cutting the teeth of wheels for clockmakers, or for other

small machinery. Why they have chosen the old-fashioned dividing-plate instead of the usual dividing wheel it is difficult to understand, the latter being not only better, but also less expensive. In other respects, this tool is well constructed.

Austria.

Wood working.

The Imperial Arsenal at Vienna supplies a very passable collection of machines for wood and metal, which are worth careful examination, and all the more because they resemble the American style instead of the English. One of these machines is for forming parallel or taper wooden poles of any description; it may even be arranged to produce irregular surfaces. This machine is of the lathe class; its peculiarity consists of two guides placed upon the bed, which are adjustable to any angle, or may be fixed parallel with the axis of the lathe. The cutting tools are held in a small portable instrument, which embraces the guides in such a manner as to push the cutters out or in as the instrument is pushed along, and thus the form of the guides is transmitted to the poles.

Wheel machinery.

Another good machine, for cutting the spokes of wooden wheels for gun-carriages, is shown; the pieces of wood are laid side by side on a sliding table and passed under revolving cutters by self-acting motion. This form does not admit of the variety of form which is secured by the Blanchard arrangement, which is now used in England and America; but, if the form of spoke is adapted to the shape which this machine can produce, it is less costly than the other.

Dovetailing and other machines.

A most ingenious machine is also shown for dovetailing and other operations connected with box-making; revolving chisels are employed, and, by means of self-acting arrangements, the table that holds the wood under operation is made to tilt first on one side and then on the other, so that the dovetailing becomes as simple as plain cutting. A machine for rifling gun-barrels is worth looking into; it operates upon four simultaneously, and is at the same time comparatively simple and practical.

Russian lathe.

Russia shows comparatively little in Class 54; there is, however, one lathe of very passable construction, in which an additional movement out of the usual course in tools of this nature is shown, no doubt intended for some special purpose. A cutting instrument can be set to work round the articles fixed in the centres, or otherwise.

Swedish screwing apparatus.

In the Swedish annexe a most ingenious pair of screwing-stocks is shown, whereby screws of any pitch or diameter can be made with a single cutting instrument, and with equal facility.

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America.

## America.

Passing to the American department, the English student will find many peculiarities which deserve his best consideration, more especially in the display made by Sellers, of Philadelphia (7). The first impression will be the striking resemblance to English tools—bold, massive, yet graceful outline, and altogether different to the usual American type; but a closer examination will reveal many novelties, and show that they can think for themselves in the arrangement of every detail. They exhibit a machine for cutting the teeth of wheels, which, when once set in motion, is perfectly automatic until it has gone entirely round, when it stops of itself and calls for the attendant. The mechanical arrangements that are introduced in order to effect the various movements necessary to accomplish so much may seem complicated, but a closer inspection will show that such is not the case. If, however, the young English student should think otherwise, let him set to work and devise a more simple combination, so that we may also have automatic machines for the same purpose.

Automatic wheel cutting

Self-acting lathes.

The two lathes shown are, in their general features, a good deal after the Manchester school; still they have some original arrangements of great merit; one is the mode of communicating the rate of self-acting feed motion. In lathes generally it is done by means of wheel-gearing, or by cone pulleys of different sizes; hence some trouble is involved in changing, and any change that can be made will depend on the relative sizes of the wheels or pulleys. In Sellers' lathe no wheels or pulleys are used, but a plain disc is substituted, a portion of which is placed between two other revolving discs that are gripped together with sufficient force to communicate motion; hence, by the simple movement of a handle, the relative position of the discs is altered, the rate of motion being dependent on the point of distance from the centre at which the motion is given off or received. Another peculiarity in these lathes is the manner in which the point of the cutting tool is raised or lowered in order to be placed in the best position for its work without requiring any packing or other makeshift; here the cutting tool rests upon a rocking bed, which may be adjusted with the utmost precision to bring the tool to the proper level. Another trifling feature in these lathes is the conversion of a portion of the bed into a sort of press or cupboard for storing away the tools and other spare gear, so as to avoid the litter so often observable;

this is not an original notion, for it has been done in England to some extent, but it is not generally done. Their two planing-machines will compare with any tools in the Exhibition, and from their peculiarities will probably give rise to some discussion.

Planing machines.

One of these planing-machines is small, and on the usual arrangement of placing the articles to be planed on a movable bed, the cutting tool being stationary. The other machine is of grand proportions, and arranged for the tool to move and the article remaining stationary. Both deserve a special notice. The small machine is cleverly arranged, especially in the manner of giving motion to the bed. Under the bed is fixed a rack in the usual fashion; but, instead of being worked by a pinion with driving-shaft, at right angles, as in other machines, the shaft is placed upon the skew, so as to place the angle surface of a worm parallel with the teeth of the rack, the worm meanwhile running in oil. By this simple arrangement they combine the advantages of the screw and the rack, and the strong construction of bed which this arrangement admits of is also a notable feature. In the construction of the large machine the table for holding the articles to be planed is part of the great bed, and is constructed with a rack along both sides. The upper part of the structure is much in the ordinary form, consisting of two brackets strongly braced together at the top, and furnished with the usual transverse slide, with tool-holder and self-acting motions. The whole of this part of the apparatus slides upon the bed, and receives motion at the top by means of a peculiar compensating band arrangement, which, by means of a transverse shaft, gives motion to vertical shafts, one at each side, which gear by pinions into the racks on the edge of the table. The mode of preventing this sliding framework from rising is ingeniously arranged, and all the details have been well matured and carefully carried out. The idea of moving the tool instead of the article, when dealing with large masses, is not new. Even 25 years ago Mr. Nasmyth had constructed such a tool for Mr. Fairbairn, and since that time others have been constructed of considerable merit. But the writer does not remember to have seen a machine of this character so likely to meet with general acceptance as the one now referred to.

Planing by the tool moving.

Steam hammer.

Sellers also exhibit a steam-hammer, with a new mode of manipulating the steam-valve, which is well worth attention. This is accomplished by means of an angular

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groove upon a continuation of the piston-rod working within a steam-case above the cylinder, a pin upon the valve-motion lever is inserted into the groove, and it is so arranged that by means of a convenient handle the position of the lever can be altered, and so made to work the hammer, self-acting, to any required height.

System of screwing apparatus.

The same firm have a fine display of screwing apparatus, entirely of a new character, and all constructed on sound principles. The great advantage, which we, as a nation, have derived from what was done by Mr. Whitworth in regard to a uniform system of screw-threads is now fully recognized by all; still it is confessed that it would have been better if Whitworth had gone one step further by entirely discarding all existing screws, and carefully attempted to work out the best system of screw-threads that it was possible to devise. That is what is now professed to be accomplished by Sellers, and which has been adopted as the national standard of screws in the United States. By this system screws of all sizes are the same in the form of the thread—namely, an angle of 60 deg.; six cutting tools for any size of screw, if placed together, will form a complete circle. The depth of the thread, the amount to be taken off the sharp point of the cutting-tool, are all derived from the diameter or the pitch, or from each other, on a well-defined principle. These screws when complete are what is technically termed "flat top and bottom," and although this system may be objected to by those who are accustomed to and prefer the "round top and bottom," yet it is very evident that the flat gives greater facility for measuring the diameter with extreme accuracy.

Screwing apparatus.

The screwing stocks and dyes which they exhibit are well worth studying carefully; the mode of compressing the whole of the dies upon the bolt simultaneously is probably the most simple yet devised, and equally perfect as a mechanical arrangement. There is also to be seen an interesting collection of parts of shafting, couplings, hangers, pulleys, and other similar articles—all exceedingly simple, of cheap construction, and no doubt most effective.

Originality.

This firm is said to be the most extensive manufacturers of such articles in the United States of America, and their display is well worth the unbiassed study of our millwrights, and of all others who are interested in such constructions. Altogether, the collection exhibited by Sellers probably contains more originality than that of any other exhibitor in Class 54 in this Exhibition.

Harris (3) has a lathe of the recent American type, quite a specimen in its way, but not such as to commend itself greatly to English notions. It contains, however, one point of interest—namely, an arrangement for adjusting the vertical height of the point of the cutting instrument in regard to the centre of the lathe. In this instance an inclined plane is resorted to ; and it may be instructive to compare this method with that of Sellers, which is close by. It also shows us how much attention the Americans are paying to such minute details, well knowing that such points are of more real economic importance than matters of greater pretension.

America. Cutting tool adjustment.

The American Tool Company (4) exhibit only one tool, a lathe, intended for brass-work—cocks, gauges, and similar articles. Although, to our ideas, this lathe may seem rather flimsy in its general structure, nevertheless, it is a perfect study in itself, and will repay a most attentive inspection. The combination of handy arrangements for boring or turning parallel or at any angle, and the facility with which screws can be formed under any conditions, is truly admirable and deserves the closest scrutiny. Its system of chucks, its swivelling arrangement of shifting headstock with square spindle, and other peculiarities, as well as the working bar for screw-cutting, together with its exquisite workmanship, place it among the gems of the Exhibition.

Lathe for brass work.

Brown and Sharp (5) exhibit a machine for making any description of screw out of the rough bar, which cannot fail to attract attention. When the screw to be made is once determined upon, every instrument necessary to its production is placed in suitable holders therein provided ; the wire or bar passes through the centre of the revolving spindle, when tool after tool is successively brought into operation, and screws of perfect identity are thereby produced with facility. America has done more for this kind of machine than any other country. The system originated in the great clock manufactories of that country, and was introduced into England by Mr. Hobbs, after 1851, for his lock-making, and afterwards it was brought into some of the operations of the War Department; but in no previous example has the system been so well developed as in this machine. The same firm also show a milling, or, as it is frequently termed in England, a shaping machine, in which circular cutters are employed. This class of tool is the great feature at the Enfield small-arms factory, and is much more used by engineers and machine-makers in America than it

Screw making machine.

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is in England. The difficulty of keeping up the sharpness of the cutting instruments is much overrated now that there are proper means for sharpening without reducing the temper.

America.

Boring machine.

Bement and Dougherty (6) show some good machine tools, all with certain points of special excellence. One is a horizontal boring machine, which has a clever arrangement for giving different rates of self-acting feed motion to the boring bar; a number of wheels of different sizes run loosely upon a spindle, but by touching a small handle that passes through its interior, any one of the wheels is at once connected and gives a rate of motion accordingly. The table of this machine is also conveniently arranged for fixing articles upon, and contains a very efficient self-acting facing arrangement whereby the facing of the ends of the cylinder is performed simultaneously with the operation of boring. Their screwing machine also is worth looking at, particularly the method of manipulating the dies, and also the piece of iron to be screwed; both are neat and convenient.

Wood machines not properly represented.

In regard to wood working machinery, the United States does not come out in its strength; and, although they had scarcely any competitors in the Exhibition of 1851, they are upon this occasion far surpassed both by England and the continent of Europe. The only machine of this class deserving close attention is a compound circular saw, where cross cutting or ripping can be conveniently and promptly brought to bear as required, and yet the combination is effected with great simplicity of parts.

America as a whole.

It will thus be seen that in this limited collection of machine tools from the United States of America there is really more to arrest the attention than in some of the more extensive displays of other foreign countries, whose tools more nearly resemble our own.

England.

## England.

Although England comes far short of what might have been expected, considering her acknowledged pre-eminence, still it will be found that, even in her barrenness, there are some rare features which show an advance over 1862.

Refinement in machine tools.

The machine tools of Whitworth and Co., and Sharp, Stewart, and Co., are of the highest order; few novelties are introduced by either, but detail after detail has been improved and refined until at length some of their machines are, probably, as near perfect as we may expect to see under present arrangements of construction.

Cutting tools.

The 12-inch lathe by Whitworth and Co. is to the refined critic, a marvel of goodness, and the closer the inspection

is made, the more will its excellence appear. One novelty in the tools of this Exhibition is the substitution of a tempered piece of steel fixed in a holder, instead of the usual cutting tool formed upon the extremity of a bar of steel. A good specimen of this instrument is shown in this lathe; although these instruments are supposed to be new, it is really an old arrangement, and was frequently used by the mule-roller turners of fifty years ago. In other parts of the Exhibition the same description of instrument is used for planing and other machines, and will, no doubt, come rapidly into general use.

Whitworth exhibits a general assortment of machine tools, large and small, all capable of bearing a rigid inspection. On some of the details a difference of opinion may be expressed—one is, in regard to the manner of communicating the sliding motion to the planing-bar of a shaping machine, the motion being given at one side and then imparted by the connecting rod to the stud upon the sliding bar nearly at the other side of the saddle. This firm also exhibit an excellent lathe for turning railway axles, specially arranged for that purpose; the axle is driven in the middle, having a shifting headstock at each end, and with the two turning saddles moved by a rocking-shaft in a simple and convenient manner. The new tool-holder in the large slotting-machine is considered a very perfect arrangement, and most effectively removes the defects of the rigid holder, as well as the movable holders, which have been in use hitherto. The machine for planing rifled shot is worth an attentive inspection; as indeed are all the tools of the Whitworth Company, who, amid all their competitors, still retain their old supremacy, and this country ought to feel indebted to them for the display made at this Exhibition.

Lathes.

Sharp, Stewart, and Co., make a display of tools almost faultless; they contain little that is really new; indeed, some of them are 1862 in their broader features. Where such excellence has been arrived at by a house as well as by a nation, the avenues of improvement close up one after the other. It is impossible to study these machines without being satisfied with the careful attention which has been given to their details, so as to render them convenient and thoroughly serviceable.

Excellence.

This firm exhibit a considerable variety of machine tools, all well proportioned. Some are greatly admired. The radial drilling machine is considered about the best of its kind; the general arrangements, as a whole, are

Radial drill.

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excellent, and especially the concentration of the handles for adjustment being brought to the point of operation, so that the driller can bring the drill to a point without wandering to the end of the radial arm, as is the case with many other machines of this class. Their shaping-machine is well arranged in regard to the mode of giving the power from the gearing to the working point. Both this firm and the Whitworth Company must feel greatly flattered by seeing the many repetitions of their forms and arrangements adopted by other tool-makers all over the world.

Leeds.

Leeds is poorly represented. That great seat of industry does not seem to have realized the duty that England had expected at this time; still, some of the best things are from that quarter.

Steam hammer.

Tannett, Walker, and Co. have a small steam-hammer of very superior construction; but we would gladly have seen some of their great hammers and forge steam-cranes, instead of such a tiny representative.

Thwaites and Carbutt, of Bradford, come out better; their steam-hammer, with its wrought-iron framing, is superb, and admired by all, and is really worthy of the occasion.

Horizontal steam hammers.

A model of the horizontal steam-hammer invented by Mr. Ramsbottom is shown by this firm; it is one of the leading novelties of this Exhibition, and has given rise to much discussion, but the majority are coming round to approval of the principle. During the Crimean War horizontal hammers were used in the manufacture of the wrought-iron Lancaster shells—four hammers, worked by a steam-engine, contained the form of the shell between them; the shell, in the form of a cylinder, closed at one end, had the open end placed between the hammers; a small amount of rapid simultaneous motion was communicated to them, and the red-hot cylinder was gradually pushed downwards, and thus made to assume the bottle form of the elongated shell. In these hammers of Mr. Ramsbottom steam is applied directly to each hammer in a manner that will admit of all the variations of the ordinary steam-hammer, and deserves the special attention of all the engineers or iron and steel makers who are interested in this subject; instead of a hammer falling upon a stationary anvil, two hammers approach horizontally and expend their whole force on the mass between them, and the shock, which would otherwise have been given to the foundation, is absorbed by the article under operation. The principle upon which these hammers are constructed is so original, and the details are so ingeniously

arranged, that it will repay the trouble necessary to understand it.

Another novelty is the steam-striker of Mr. Davis, from the Viaduct Works at Crumlin. By means of this ingenious and simple combination the ordinary form of sledge-hammer can readily be made to rise or fall to any height within certain limits, to turn round to any of a series of anvils surrounding it and in any position, and to strike out in any direction. This seems a likely tool to be developed in many different ways, if it is found useful to the world in its present form. Steam sledge hammer.

In machine tools Shepherd, Hill, and Co. furnish a few good examples; their lathes, especially, are very superior; the fitting of the slide-rests and other important parts is all that the most exacting could wish for. A small machine for turning nuts is noticeable. A series of instruments are brought to bear which contain within them the required form of the article; this principle has been largely developed in America, and of late years to some extent in England, but is still capable of much greater development wherever similar articles have to be produced in great numbers. In many of the drilling-machines of this Exhibition the old-fashioned flat drill is still to be found. This house exhibits the spiral drill, which is in every respect superior. Concentration of cutting instruments.

Wilson, Brothers, of Glasgow, exhibit a radial drilling-machine upon a new system of arrangement, which is a relief from the usual stereotype. In this tool the flat surface is departed from and the cylindrical adopted; the main upright cylindrical stand is set upon a convenient drilling table, and having within it another concentric cylinder adjustable in every direction; from it a cylindrical radial arm branches off, which is mounted with a very neat drilling apparatus. Although this combination is much admired by many, still a difference of opinion is freely expressed. The question arises in regard to the possibility of fitting the cylindrical surfaces so perfectly as can be done with flat surfaces, and, even if it may be done with equal soundness, can compensation for wear be equally well secured with the full retention of the original accuracy. The disposition of the metal is well proportioned, and likewise the transmission of power is conveniently arranged, and the various appliances for holding articles under operation have been carefully thought out. As a whole, this new machine is a welcome addition and an inspection even of its defects will suggest to many minds that this order of Radial drill.

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arrangement is capable of being developed in various ways.

England. Punching and shearing.

The large punching and shearing machine of Mr. De Bergue is a beautiful and compact construction, which is much admired, and all the more that it is not a copy of the machines by some other makers. It is a new design, both in construction and arrangement, prepared to stand or fall upon its own merits.

English exhibitors limited.

The lathes and the machine and other tools exhibited by Great Britain in Class 54, although limited in number, are really all first class, and worth a careful inspection; and, so far, help to make up for the deficiency in the British department. At the same time, England feels the want of the productions of many of her leading houses whose names have become household words among engineers. There is nothing from Nasmyth or Hulse; from Smith, Beacock, and Tannett, or Fairbairn. We miss Greenwood and Batley, and many others who can ill be spared in this great competition.

Wood-working machinery.

In machinery for working wood England is comparatively better represented than in machinery for treatment of metal. As an industry, it is of limited extent, but most of the leading houses make some display. This branch of the trade has been mostly developed since 1851.

At the commencement of the present century the inventions of Bentham and Brunel paved the way for almost all that has since been effected. The celebrated block machinery at Portsmouth contains the elements of production of form as derived from a permanent copy in contradistinction to dependence upon the skill of the workman; and, although the nation was slow to recognize the importance of the principle—or, at least, was backward in adopting it extensively in the various operations of building, carpentry, and cabinet-work—it is not to be inferred that nothing was done in this direction. For many years Bramah had constructed machines for planing wood on a large scale by means of knives on a revolving wheel; M'Dowall had introduced his system of planing boards by fixed knives, the four sides being finished at one operation; and, still more recently, Tannett had constructed his copying-machines for the manufacture of carriage wheels; but still, for various reasons, the nation did not realize the great economical advantage to be derived from such apparatus, and hand labour was mostly employed in working wood long after the time when planing and other machines had been employed upon iron.

England.

Progress in wood working by machinery.

The scarcity of labour in the United States of America had, during the interval, been gradually fostering a series of extremely simple machines to assist in every kind of operation. At the Great Exhibition of 1851 a number of these simple machines were displayed. They were mostly constructed of wood, in an exceedingly primitive manner, according to English notions; and the ridicule which was at first excited was very quickly dispelled when they were set in operation, and soon produced a complete change in the public mind, which led to the most important results. Before 1855 several houses had entered heartily upon the work. The French invention of the band saw of that year by M. Périn gave another impetus, likewise the importation of the gun-stock machinery for Enfield in the previous year each tended to open up the subject; so that by the year 1862 the display of wood machinery by English houses was upon a grand scale, and the sound substantial character of their general construction placed them far above the more flimsy American productions.

The display in 1867 not equal to 1862.

In this Exhibition, although proportionately with the extent of the industry, wood machinery of the generally useful class is moderately well represented, still it comes short of 1862. We miss the more exquisite tools of that year. The gun-stock machine for bedding the lock, from Greenwood and Batley, and other machines of analogous character, gave a high tone to the national display, which is entirely wanting on the present occasion.

Mortising.

Of the four English houses who make the best display Robertson & Son of Rochdale is the most conspicuous. Their machines are all of the most substantial character, admirably arranged so as to afford every facility and convenience in working, combined with great simplicity; at the same time, there is not so much novelty as might have been expected. Their chief effort is in the class of machines that are required in great numbers, and are similar in finish to those sold in their ordinary business. Of these machines, one for mortising is about perfect—so nicely balanced in its working parts, and arranged so as to put on the break of the operation of stopping in a very effective manner.

Tenoning.

The tenoning-machine also is very perfect and complete. It is susceptible of any adjustment, and may be set to cut a long and short shoulder, or both of the same length, with equal facility. The machine for producing mouldings, with its anti-frictional spindles, would seem to fulfil all that the builder can desire; and it is extraordinary that, with such machines in existence we should still have so much of the

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hand-planing system in operation. Their circular saw bench, with its arrangement of gauges, is also well combined. The same may be said of the jigger-saw, in which the punching of holes in the saws is obviated by a method of gripper, which answers the purpose equally well; indeed, all the machines of this house have the same character of goodness and general adaptation for the purpose intended.

Machines for working wood.

Another extensive exhibition of this class of machinery is by Powis, James, and Co., of London; and, judging from the admirable display here made, it is difficult to draw a line of comparison between them and the firm of Robertson & Son, they are both so very superior. One of their machines in particular is very good; it acts at one time upon the four sides of any piece of wood of any form; it is susceptible of any adjustment, and has a self-acting feed that can be graduated to any desired rate, and without any complication. To engineers who have to prepare lagging for steam-engine cylinders this machine is well adapted, and, being of good workmanship and sound construction, is likely to receive attention. A moulding-machine is equally good, and seems to have been well thought out in all the details.

As has been remarked already in regard to Robertson and Son, so here also there is little novelty, unless it is in the mode of backing the endless band-saw in a separate box and the manner of tightening the jigger-saw by a coach-spring arrangement. Both seem good and likely to give satisfaction in ordinary working.

Machine joiner.

Worssam and Co., of Chelsea, exhibit some admirable tools for working wood; their great specialty lies in the class of machines that are used by builders, in which class they occupy a prominent position for good, honest, sound workmanship, and not without considerable originality in their arrangements. The "general joiner," shown by this house is a valuable tool, capable of performing an extensive variety of operations, with comparatively little trouble in the adjustment of the machine; and altogether, the display which is here made fully maintains the high character of this firm.

Wood machines worked by hand.

A fourth house, Charles Powis and Co., of London, also make a moderately good show. Their machines are generally of a lighter character than those of other houses; some are adapted for power, others for manual labour, but all seem very handy, and may be considered good practical machines, likely to be generally useful in the smaller workshops of the country. Their universal joiner and mortising-

machine are both most useful tools, and worthy of extensive adoption.



England.

The lesson taught.

The one great lesson taught by this Exhibition is this, that for the future we have no monopoly in machine tools, either for wood or iron ; and, if we are to hold our own, it will only be by the united effort of masters and workmen. The advantages of coal and iron, which we so abundantly enjoy, may be overrated ; the means of transport are such that any difference of cost may be counterbalanced by the conditions of labour. Our workmen must be prepared to understand that foreign competition will determine the prices of machinery and the wages that can be paid to workmen, and that combinations and strikes are not only useless, but are really disadvantageous to their own interests. Besides, such disputes alarm the capitalist, and dry up the mental energy of those who have to plan and originate. The time has arrived when the most strenuous exertions will have to be made by us all in order to produce machinery of high quality at a moderate cost ; to secure this we require harmony and the co-operation of all concerned. We also require greatly increased facilities for becoming acquainted with foreign scientific literature, in order to know the inventions and progress of other countries, seeing that both France and Germany are familiar with all that takes place in England.

That there is no lack of talent or invention is abundantly evidenced by our past history, but, unless we have the same advantages, especially in regard to theoretical and mathematical education, which are so abundantly enjoyed by those countries, the competition becomes so unequal that no inherent skill or ability can long withstand it. We require better education for all our leading workmen, and more especially for draughtsmen, foremen, managers, and masters, and to be given in such abundance all over the kingdom as will not make the possessor the exception, and so cause him to feel above the drudgery of his daily work. Such a general diffusion of systematic theoretical knowledge relating to the principles on which engineering and machine-making depend will bring out the latent talent of the country. Of practical knowledge and skill there is great abundance, and when in addition the head has been trained as well as the hands, together with the inherent perseverance of our national character, we may still hope to retain our position in the world.

A better education required.

## Report on Apparatus and Processes used in Spinning and Ropemaking.—(Class 55.)—By Peter Le Neve Foster, Jun., C.E.

Mr. Le Neve Foster, Jun., on Apparatus, &c., used in Spinning and Ropemaking.

In this class is comprised all machinery and apparatus used in the preparation and spinning of textile materials, of which cotton, wool, flax, hemp, and silk are the most important. The materials and machinery used for rope-making are also included in this class, together with ropes and cordage of all kinds.

From the great difference existing in the nature of textile materials, and even in their individual qualities, different modes of treatment are necessary. In cotton, for instance, the length and quality of staple varies not only in different but even in the same species.

Processes in cotton manufacture.

The first process in cotton manufacture is the separation of the seed from the staple by means of gins; the next is to clean and open the bales of cotton, which arrive at the mills in a highly compressed state. This is effected by means of scutchers and beaters, with ventilators to free it from dust. The cotton is delivered in an even fleece, ready for the third process—that of carding—by means of which the fibres are drawn out straight and parallel, and delivered in "slivers" or bands of cotton. In some cases a combing machine is substituted for this, and is especially adapted for the treatment of the fibres of fine numbers. In the fourth process these slivers are drawn out and doubled, in order, by the repeated mixing of the staple, to equalise their consistence and substance, and to arrange the fibres perfectly straight and parallel. In the fifth process the slivers are delivered to the slubbing, intermediate, and roving frames; where the yarn receives the first twist, and is repeatedly drawn, doubled, and twisted, ready for the spinning operation, which finishes the extension and twisting of the yarn either in a continuous manner on the throstle or in a discontinuous manner on the mule finally, and wound upon bobbins.

Wool.

Wool is of two different kinds—the long and the short staples, each of which requires a different manner of treatment in the preparation and spinning processes, as also in the treatment of the cloth after it is woven, in order to fit it for the market.

The length of the fibres of long wool varies from 3 in. to 8 in.; this is not carded as cotton, but combed like flax or hemp, either by hand or by machinery. Short wool is seldom

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more than 3 in. or 4 in. in length, and is carded and felted, by which process the filaments become first convoluted and then closely matted together. The shorter sorts of combed wool are used principally for hosiery, and the longer are manufactured into hard yarns for worsted pieces, such as waistcoats, carpets, poplins, crapes, &c.

The wool used for the manufacture of good cloth should not only be shorter but generally speaking softer and finer than the worsted wools, in order to suit it for the fulling process.

Flax machinery.

Flax machinery is required to be made much stronger than that for cotton, and requires more power for driving it. The greater cost of flax yarns arises from the practical difficulties in converting and working the raw material.

Flax, hemp, and jute are all spun by machinery on the same principle, but with differences in size and proportions. Hemp is not only inferior in fibre to flax in softness and substance, but is more difficult to spin.

The leaves of the aloe also furnish an abundance of fibre from which ropes are made. Some excellent specimens of cordage made from this fibre are exhibited.

Silk machinery.

The machinery for the treatment of silk is extremely simple, there being no preparatory machinery required as for cotton. Silk is imported in skeins wound direct from the cocoons.

The first process is the winding of the skeins as imported on to bobbins, and removing the irregularities and knots by passing the fibre between the edges of the cleaner, formed of two bars of steel, adjustable by screws, to pass extra maximum thickness allowed, and to intercept fibres of the thickness. It is then doubled, twisted, and reeled. These processes are called "throwing silk."

Floss silk, or "bourres de soie," consists of the shorter broken silk, which is carded and spun like cotton.

In France the principal part of the machinery used for the manufacture of cotton is made at Rouen; flax and hemp machinery, at Lille; Alsace furnishes cotton machinery, and machinery for carding and combing wool and floss silk.

## France.

France.

Cotton machinery.

One of the most important exhibitions of cotton machinery is that of Messrs. Schlumberger and Co., of Guebwiller (Haut Rhin) (19 and 51). It consists of a "breaker" carding engine with automatic stripper for "top flats," on which there are 18, on "Wellman's" system. The cotton is opened and cleaned by a pair of working rollers before

reaching the flats. The flats are lifted out of their places for the purpose of stripping without being turned over, and a wire brush is drawn across the face of the flat to remove the fly and dust. The flat is pressed gently down upon the brush during the action of stripping. The mechanism for stripping is effected by cams, and is particularly ingenious and simple, and imitates stripping by hand.

Carding-engine.

A double carding engine, consisting of a first, or breaker, cylinder, fitted with four pairs of working rollers, and the "finisher" cylinder, with 10 self-stripping flats, on Wellman's plan, is shown by this firm. The doffing-comb is fitted on a hollow steel axle.

Combing-machines.

The combing machine exhibited by Messrs. Schlumberger is the invention of M. Heilmann, of Mulhouse, and is especially adapted for combing cotton of fine numbers. The lap is placed on two revolving wood rollers at the top of the machine, by which it is caused to unwind and deliver a sheet of cotton down an inclined guide between fluted steel rollers, which place the cotton between the open jaws of a pair of iron nippers; the nippers then close, and by suitable cam motions are made to approach the revolving comb-cylinder, where the cotton is held by them till all the short fibres and impurities are cleaned out. The combs are cleared of fly and dirt at every revolution by a cylindrical brush. As soon as the combs have passed through the cotton, the nipper recedes from the cylinder and opens, to allow the partly combed fibres to be partially drawn out of the lap by means of a leather-covered roller, working for this purpose in contact with the fluted segment on the comb-cylinder, and with fluted detaching rollers. The drawing out of the fibres causes the ends, which were previously held in the nippers, to pass between the teeth of a fine comb, and thus prevents any waste being drawn forward.

The machine is arranged in such a manner that the tuft of cotton is deposited on the detaching roller so as the ends overlap each other, and are united in a continuous sliver, to be deposited in a coiling-can on one side of the machine, whilst the waste is coiled in a can on the other side. This machine is made with six deliveries, each of which produces 13½ lb. per day.

A combing-machine for wool, on the same principle, is exhibited by these makers.

The slubbing and roving frames exhibited by this firm are of the usual construction.

The self-acting mule of Messrs. Schlumberger is most ingeniously arranged, and adapted for spinning fine numbers.

These makers also exhibit a set of two carding machines

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Carding and combing machinery.

for wool, consisting of "scribbler" and "condenser;" these are of the usual construction, with ordinary feed lattice, &c.

The best display of wool machinery is that of M. Mercier, of Louviers (Eure) (37); it consists of both carding and combing machinery for short and long wools. Carded wools undergo the following processes:—

The burring machine, 48 in. in width, is provided with Bolette's self-acting feeder, consisting of a hopper, into which the wool is thrown; at the bottom of this hopper is a travelling lattice, for the purpose of bringing the wool forward within range of the hook-shaped teeth of a vertical lattice, by means of which the wool is lifted in a regular manner and feed into the beaters, the first of which is a cylinder with four longitudinal blades; it then passes to the second, a cylinder armed with four rows of strong teeth. This double beating has the effect of opening the wool and facilitating its being taken by the teeth of 54 comb blades fixed on a hollow cast-iron cylinder 22 in. in diameter; between each comb-blade a long slit is made about 3-8ths of an inch in width, extending the whole length of the cylinder; this is for the purpose of keeping the combs free.

The openings of the grating under the first beater can be regulated so as to facilitate the exit of the burrs.

The production of this machine is from 88 lb. to 110 lb. per day.

In the next process, of teazing, the wool is put into the self-acting feeder of a machine, consisting of an iron cylinder covered with 24 iron bars, each armed with a double row of strong teeth 2 in. in length. This machine is provided with an arrangement for oiling the fleece previous to its being carded, for the purpose of softening the wool and preventing the short fibres from flying.

The wool is next carded in a set of three machines, consisting of "scribbler," "intermediate," and "condenser." The main cylinders of these machines are 44 in. in diameter, each with five workers and five strippers about a fourth of the size of the workers. These machines are 44 in. in width on the wires.

The wool is supplied to the "scribbler" by means of M. Bolette's self-acting feeder; and the burrs are knocked out from the wool before reaching the main cylinder by means of a small burring roller armed with saw-blades.

The sliver delivered by this machine passes on an endless feed-cloth to the "intermediate" card, where it is laid obliquely across the feeding-lattice by means of Apperly and Clissold's patent feeder. The sliver delivered by the intermediate serves to supply the condenser in the same manner.

The fleece is stripped from the condenser by two doffers, and the 50 strips are felted by passing between two pairs of endless leather bands or rubbers having an alternate motion across them. This machine delivers 50 good threads and two wasters at ends.

M. Mercier exhibits a self-acting mule of 400 spindles, fitted with a "double speed," which is very serviceable; it being desirable to twist the thread whilst being drawn just sufficiently to prevent its breaking, and when the carriage is at the end of its stretch to give it an extra twist.

For the treatment of long wool M. Mercier exhibits a carding engine 44 in. in width, consisting of two main cylinders, and provided with a self-feeding apparatus, similar to that previously described, breast rollers, and burring-cylinder armed with saw-blades.

The wool, after the burrs have been knocked out by the burring-cylinder, is transferred to the breast-roller furnished with three working rollers and clearers, where it is prepared for the first main cylinder; this is followed by another roller of the same diameter as breast roller to prepare it for the second main roller. The fleece is removed in the usual manner by the doffer and a vibrating comb, and formed into a sliver which is wound into a ball for supplying the combing machine.

Mr. Noble's invention.

The combing machine, which is of most novel construction, is the invention of Mr. Noble, and produces from 200 lb. to 700 lb. per day.

This machine consists principally of a circular horizontal comb, about 5 ft. in diameter, formed of needle points, with two small circular combs revolving tangentially to the larger one on the same diameter. The balls of slivers, 72 in number, are placed in a framework underneath, and, revolving with the comb, the ends of the slivers pass separately through holes and through guide troughs; the slivers are kept from unrolling too quick by a small weight under which they pass in the troughs. These troughs, in revolving as they approach the points of contact with the smaller combs are raised, by means of a fixed cam or incline, up which they travel. The ends of the slivers passing to the comb are pulled out by the slight resistance offered by a bar under which they pass; the ends thus pulled out project over the inner and outer combs at their two points of contact, and the tufts of wool are placed on the teeth of the combs by a descending brush at each end of the crank-shaft, making about 300 revolutions per minute whilst the large comb makes from $3\frac{1}{2}$ to 4 revolutions. As the combs revolve, the ends of the tufts of wool placed on the teeth are guided by endless bands of leather

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between four pairs of fluted rollers, which are placed in convenient situations for the purpose of forming two slivers from the large comb and one from each of the smaller ones. These four slivers are then passed to the top of the machine, where they are formed into one by passing through a series of rollers and wound into a ball. The short refuse wool remaining between the teeth of the combs are removed by triangular plates or cleaners, and lead away to cans placed at the bottom part of the machine.

The fibres of the wool are drawn out and laid parallel, either after combing or carding, by means of a "screw gill." The gill head is supplied with a certain number of balls of sliver, which are placed in a crul or framework for that purpose. This machine is composed of an endless succession of bars called "fallers," bearing combs of closely-ranged steel points, through which the slivers are drawn. These bars are guided forwards by means of two screws with an eccentric at the ends for the purpose of lowering the gill bar on to another pair of screws revolving in the opposite direction, by which they are brought back to their former position, into which they are lifted by other eccentrics. These slivers are held back by a holding-back roller, so as to allow the teeth of the gills to act upon the wool.

A self-acting mule of 450 spindles and four rows of drawing rollers is exhibited by these makers.

Thread felting machine.

M. Vouillon, of Louviers (Eure) (38), shows a machine, constructed by M. Mercier, for the production of "fils feutrs," threads which are not spun, but felted. The 30 slivers from the condenser are passed, on an endless felt band covered with linen, under four wooden rollers, covered in a like manner. These rollers have an alternate motion across the endless band, and in this manner the slivers are rubbed into yarn. A steam-pipe is introduced between the first two rollers for the purpose of heating the wool in order to facilitate the operation of straightening the fibres.

Messrs. Stehclin and Co. of Bitschwiller (Haut Rhin), (61), exhibit both woollen and cotton machinery.

Carding and combing machinery.

For cotton, they exhibit a set of two carding machines with the intermediate process of lap doubling. The "breaker" carding machine is of the usual construction, with workers and cleaners, and the "finisher" is furnished with 18 self-stripping flats on Wellman's system. Besides these, this firm exhibit drawing, slubbing, and roving frames, and self-acting mule, of good design and construction. The self-acting mule is of 442 spindles, with four pairs of drawing-rollers, the end pair of which are weighted. The chief novelty in this mule is the form of the carriage, the back of which, in

plan, forms a parabolic curve, instead of the back and front being parallel, as those generally in use.

For wool they exhibit two carding machines and a circular wool-combing machine of ingenious design. The wool, in 10 or more slivers, are led forward by a screw gill, on which it is placed by a descending brush; the tuft of wool is then seized by a pair of jaws, that take it forward; a comb next takes it from the jaws and deposits it on the revolving circular comb; the ends of the fibres which project outside the teeth of the comb are guided, by an endless leather band, to a pair of fluted rollers, by means of which they are drawn away from the teeth of the comb and formed into a sliver by passing through the centre of a hollow revolving cone, and deposited in a can at the side of the machine. The waste wool remaining between the teeth of the comb is cleaned out by means of triangular plates, and drawn away by a pair of fluted rollers and deposited in another can.

The production of this machine is from 220 lb. to 660 lb. per day, according to the quality of the wool that is combed.

Messrs. Morel and Co. (82), of Roubaix, Nord, also exhibit a circular wool-combing machine. The slivers, supplied from 15 bobbins fixed in a creel, are brought forward over the circular, horizontal revolving comb, where the tuft of wool is seized by a pair of jaws and placed upon the teeth of the comb by a descending brush; the fibres projecting from the comb are guided by an endless leather band, and are drawn away by a pair of fluted rollers and formed into a sliver, which is deposited in a can. In this machine there are two feeds, the one opposite the other; and two slivers of combed wool are formed, one on each side. The short waste wool is cleaned from between the teeth of the comb by means of triangular plates, and led away by a pair of fluted rollers to a can. The circular comb is formed of eight concentric rows of steel teeth fixed on a revolving cylinder; the cam motions by which the jaws and brush receive their respective movements are formed by a projection cast on the inside of the cylinder.

Cleaning and spinning machinery.

Messrs. Pierrard-Parpaite and Sons (93), of Reims (Marne), show important and well-constructed machinery for cleaning and spinning wool, consisting of opener, scouring and wringing machine, carding-engine, and continuous spinning-frame.

The opener consists principally of a cylinder provided with a quantity of conical teeth fixed, slightly inclined in the direction of the revolution. The wool is fed in on an endless lattice, the fibres are drawn out and opened, and the inclined teeth tend to send the wool forward and deliver the wool on the opposite side of the machine.

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The scouring machine consists of several vats, into which the wool is steeped, containing hot alkaline lye, where it is worked about by forks moved by cranks; it is then taken out, rinsed, and dried. These vats are placed at different levels, so that the liquid in the top one, which receives the clean water, can be emptied easily into the next, and so on in succession. The wool is dried by being passed between rollers covered with woollen felt, which undergo considerable pressure, and effectually squeeze out all the water.

The carding machine exhibited by this firm is of usual construction, with double doffing rollers and leather rubbers for felting the threads.

The principal feature in the spinning-frame is that the spindle and flyer work quite independently of the other, and are driven by independent gearing, the flyer with a constant, and the spindle with a variable, speed. Each spindle and flyer can be stopped in a very simple manner, without its being necessary to stop the whole machine. The bobbins filled with yarn from the roving-frame occupy the top part of the machine, and pass through the usual pairs of drawing-rollers to the spindles through the hollow part of the flyer, which is provided with arms of equal length with a spiral groove cut in one of them, down which the thread is led, and in this manner is protected from the effects of the centrifugal force occasioned by the high speed of the spindles.

A continuous spinning machine is exhibited by M. Ryo-Catteau (35), of Roubaix (Nord), the rail of which is lifted by a cam motion arranged in an ingenious manner.

Flax-hackling machinery.

A flax-hackling machine, with vertical sheets, is exhibited by Mdme. Ward (159), of Lille (Nord). The flax, suspended in its holder, is passed progressively from one side of the machine to the other on a slide placed above the hackle-sheets, and is thus hackled at the same time on each side in its course through the progressively finer hackles. The hackle-sheets are kept clean by means of brush-rollers at the bottom part of the machine, and then are cleaned by means of rollers covered with card-clothing, from which waste is doffed by means of a vibrating comb. The vertical sheets run together parallel, and are so geared that the hackles of one intersect the interstices of the other.

Rope-making machinery.

The only rope-making machinery in the Exhibition is that shown by M. Ouarnier-Mathieu (54), of Compiègne (Oise). These machines occupy but little space, and ropes of great length can be made without the necessity of long ropewalks.

Throstle.

M. Vimont (60), of Vire (Calvados), shows a throstle, or continuous spinning-frame, of novel construction. The wool, after passing through the drawing-rollers, is twisted by passing through a small eye, making about 3,000 revolutions to the

tension. The tenison is produced by the thread passing over two triangular flyers. The winding on is effected by the ring and traveller, and the coping motion by a rack and pinion for lifting the rail.

A most effective machine is exhibited by M. Buzzon, of Paris, for preparing shoddy of woollen rags, for re-carding and tearing up other rags for papermaking, &c. The rags are fed in by means of an endless feed-cloth between a pair of iron rollers, the bottom one of which is covered with india-rubber, within range of a drum making about 1,000 revolutions per minute, covered with steel teeth resembling those of a circular saw; the top roller is kept clear by means of a knife which prevents the wool being wrapped round it. The drum is cleared of wool on the delivery side by a circular brush. This machine requires about $1\frac{1}{4}$-horse power, and produces from 300 lb. to 400 lb. per day.

Rag machine.

A circular wool-combing machine is exhibited by Messrs. Prouvost and Co. (43), of Roubaix, Nord.

Eight slivers contained on bobbins are placed in a creel, and their ends are brought forward on a carriage, working on a horizontal slide. The tufts of wool are taken by a comb having a backward and forward movement towards the revolving circular comb, on which they are placed by a descending brush. The ends of wool projecting on each side of the comb are guided by endless bands of leather; and the two slivers thus formed are drawn into one by a pair of fluted rollers through a hollow, revolving comb, and deposited in the coiling-can. The waste wool remaining between the teeth of the comb is cleaned out in the usual manner, by means of triangular plates.

Ropes and cables.

The principal exhibitors of ropes and cables are Messrs. Besnard and Genest (36), of Angers, Maine-et-Loire, who show a pyramid composed of wire and hempen ropes and cables for the Imperial and merchant navy; a coil of flat rope made from the fibres of the aloe, for the mines of Blanzy, 231 fathoms in length and weighing upwards of three tons; a coil of flat wire rope, weighing upwards of four tons and 260 fathoms in length, intended for the use of the mines at Creusot; a flat hempen rope, 300 fathoms in length and weighing upwards of five tons, with various other coils of cables of large dimensions for mining purposes, form the base of the pyramid. Upwards of 800 workmen are employed by this firm for the manufacture of cables and cordage, with an engine-power of 300 horses.

The machinery used by this firm has been chiefly furnished by Messrs. Combe, of Belfast, for combing hempen and other fibres, and the carding engines of Fairbairn, of Leeds.

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Some excellent samples of wire, hempen and rope, made from the fibres of the aloe, are exhibited by Messrs. Marcheteau, Potraies, and Laroche, of Angers (33).

The Commission des Ardoisières of Angers (98) show some good samples of both flat and round wire rope.

The generality of the cables and ropes in the French department is of excellent quality.

Card-clothing and separate parts of machinery.

The principal exhibitors of card-clothing, separate parts of machinery, such as spindles, flyers, bobbins, gills, combs, used in the preparation of textile fabrics are Messrs. Harding-Cocker, of Lille (120), Messrs. Scrives, of Lille (133), Messrs. Metcalfe, of Meulan, Seine et Oise (21), and numerous other firms.

The machinery for silk-throwing does not generally present any special features or novelties in construction.

Some excellent apparatus for weighing and testing the strength of silk and parts of silk-throwing machinery are exhibited by Messrs. Burdet (149), of Lyons, Mr. Alcan, of Paris (22), and a few other exhibitors.

Algeria.

## Algeria.

Cotton gins.

In this section some effective cotton-gins are exhibited by M. Chanfourier, of Paris. They are adapted for opening and cleaning any kind of staple, whether long or short. The cotton is drawn between a pair of steel rollers, working nearly in contact, and so close as not to allow the passage of an ordinary sheet of paper, and which stop the passing of the smallest seeds which drop through the grating in front of the rollers. The fibres are drawn through by means of wooden rollers covered loosely with leather, which effectually prevent the cotton from being wrapped round the steel rollers. Another pair of leather-covered rollers placed at the back continue the drawing of the fibres through the gin and keep the first pair clean. The chief novelty introduced in this machine is a small fan which sends a current of air on the steel rollers and tends to keep them cool. The machines are cheap, and can be recommended for use in countries whose skilled labour is scarce, as they can be put in order by any person of ordinary intelligence.

Holland.

## Holland.

The exhibitors in this department are few in number, and only show some samples of cables and cordage.

## Belgium.



The manufacture of machinery for the preparation and spinning of textile fibres is most prosperous in Belgium. Verviers is the principal seat for the construction of woollen machinery, and Ghent for cotton machinery. Machines, both for cotton and wool, are constructed in large numbers at Liège.

Cables and ropes.

A good assortment of cables and ropes of various kinds is exhibited by Vertongen Goens, of Termonde (13). In this town and in the neighbouring communes upwards of 8,000 persons are employed in ropemaking.

Woollen machinery

M. Celestin Martin (5) exhibits a complete assortment of woollen machinery, consisting of opening machine, set of carding machines, and self-acting mule.

The first machine is for the purpose of opening and oiling the fleece previous to carding. It is provided with self-feeding apparatus somewhat similar to that described in connexion with M. Mercier's machinery in the French department. The wool is opened by a revolving beater with iron blades, and passes on a travelling lattice to the oiling apparatus, which consists of a trough containing the oil which is tipped over in a slow and regular manner by a suitable arrangement of gearing, so that the requisite quantity of oil is poured out on to a revolving brush-roller, and in this manner the wool is sprinkled as it passes under towards a drum covered with short steel points, from which it is delivered in a fit state for carding.

This machine is of great importance for the preparation of wool for the manufacture of cloth and other woollen stuffs; a careless oiling of the fleece causes irregularities in the threads and unequalness in the cloth.

The set of three carding machines consists of a "scribbler," provided with self-feeding apparatus; the fleece is stripped in the usual manner from the doffer, by a vibrating comb, and formed into a sliver, which is wound into a ball. The "intermediate" card is supplied by 40 of these balls of slivers, which are placed in a creel. The sliver delivered by this machine is of twice the size of the former and is wound into a ball. This ball serves to supply the "condenser," the end passing through an eye fixed in an upright is led through another eye, which is made to traverse, by means of an endless leather strap, for the purpose of folding the sliver backwards and forwards on the taker-in or feed-rollers. The fleece thus formed is divided into parallel strips by thin steel blades, which are stationary between the carding-cylinder and the doffer; the 64 strips and two wasters are then

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felted by being rubbed between two endless bands of leather stretched on pairs of rollers having an alternate transverse motion; the threads thus formed are wound upon rollers. This machine works about 150 lb. of wool per day.

The self-acting mule exhibited by M. Martin may be remarked for the great simplicity in the arrangement of the various parts of the headstock, which are easily accessible in case of repairs.

Messrs. Houget and Teston, of Verviers (4), have a good display of machinery for preparing and spinning wool, consisting of scouring and rinsing machines, a burring and opening machine, with self-acting arrangement for oiling the fleece. The "lap," or fleece, formed by this machine is rolled continuously on a cloth which effectually protects it from any damage that might occur from carriage, whilst at the same time the evaporation of the oil from it is checked. The "scribbler" card is 44 in. in width, with five pairs of workers. The feeding-table is so arranged to take in the "lap," whilst the cloth is wound upon a roller underneath as the lap is unwound. The fleece is stripped in the usual manner from the doffer by a vibrating comb, and formed in a sliver, which is led by an endless feed-cloth to supply the "finisher" carding machine by means of Apperley and Clissold's patent diagonal feeder.

Messrs. Rens and Colson, of Ghent (5), exhibit a throstle-frame for spinning flax.

The Société du Phenix, of Ghent (9), show a carding machine, drawing-frame, and roving-frame of 112 spindles.

Prussia and North Germany.

## Prussia and the States of the North German Confederation.

Woollen machinery.

The principal exhibitor in this department is M. Richard Hartmann, of Chemnitz, Saxony (20), who shows a very complete assortment of woollen and flax dressing machinery.

The wool-carding machinery consists of a double cylinder carding engine, in which the wool is prepared for the "condenser," formed into a sliver, which supplies the latter by means of Messrs. Apperley and Clissold's patent feeder. The shaft on which the stripping-comb is fixed is extremely heavy, and the arrangement tends considerably to diminish the vibration of the machine.

The arrangement of the apparatus for felting the threads is altogether novel. The endless leather aprons generally in use are replaced by a pair of leather-covered rollers, which are rotated by suitable gearing. An alternate motion is given to them by eccentrics, which can be regulated at

pleasure, so that the rubbing may be more or less, as may be required for different qualities of yarn.

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A self-acting mule of 180 spindles, for spinning wool, is also shown by Mr. Hartmann.

The flax machinery exhibited by this firm consists of "spreader" for long line. The endless succession of gill-bars is well arranged so as to remedy the noise and wear and tear which ordinarily attend these machines by the too abrupt and violent descent of the faller. The body of the line in this machine is drawn out to from 25 to 45 times its original length.

Flax machinery.

The second drawing is effected by a drawing-frame for six slivers. The proportion of drawing of the flax in this machine is from 14 to 20.

The roving-frame of 70 spindles for bobbins 8 in. by 4 in.

The carding machine for tow is 6 ft. in diameter and 5 ft. in width, with six pairs of workers and clearers and three doffing-rollers. It is fitted with a bell arrangement for stopping the machine when from 300 to 600 yards of sliver have been delivered.

A drawing-frame with three heads for six slivers each. A throstle frame for wet spinning is also shown. It has 176 spindles. The drawing-rollers are in gun-metal, and the weighted rollers of gutta-percha.

Some excellent samples of wire and hempen rope and cables are shown by M. Heckel, of St. Johann, near Sarrebruck (7).

Ropes and cables.

## Baden.

Baden.

Three exhibitors only send specimens of hempen and wire rope, also some cordage made from cotton.

Ropes, &c.

## Bavaria.

Bavaria.

The ropeworks of Fussen send some good samples of twine and fine cords.

Cords.

## Austria.

Austria.

M. Giradoni, of Vienna (5), exhibits a double-carding machine for cotton; the arrangement of this machine is exceedingly novel, and a great economy of floor space is obviously gained in this manner. The carding-cylinders are placed one on the top of the other, instead of side by side, as is usually done. The workers and cleaners are

Carding machine.

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placed round nearly the entire circumference of the carding-cylinders, and the space through which waste can be thrown off between the first and second carding-cylinders being thereby reduced. The fleece is delivered from the first or "breaker" cylinder, to the second, or "finisher," which is surrounded by a pair of rollers and breaker, with six smaller rollers underneath. The doffer and stripping-comb are of the usual construction, and deliver the finished sliver to the coiling-can. The fly from the first cylinder falls into a box, and the combings from the second cylinder drop out below the machine. The production is stated to be from 150 lb. to 220 lb. per day, with a total waste of from 4 to 5 per cent of raw materials used, fly, combings, and strippings included.

Card-clothing.

The other principal exhibitors from this country are Messrs. Hachnel, Manhardt, and Co., of Bielitz, Silesia (6), who show some good samples of card-clothing for woollen goods.

Messrs. Blumenstock, of Reichenberg (2), and M. Angeli, of Trieste, also exhibit good samples of card-clothing for cotton, woollen, and flax machinery.

Switzerland.

## Switzerland.

Cotton machinery.

The principal exhibitors from this country are M. Rieter and Co. (2), of Winterthur, who have a large display of cotton preparing and spinning machinery. The first and second machines are for the purpose of opening and cleaning the cotton as imported in bales, and forming it into a lap to supply the carding machines. The carding is effected by two machines only—that is to say, double carded, with the intermediate process of lap-doubling. The "breaker" carding machine is furnished with six working rollers and cleaners; the fleece is stripped from the doffer in the usual manner with a vibrating comb, and is contracted and drawn through a tube by means of a pair of rollers into a sliver, which is delivered and coiled in a tin can revolving slowly on its axis.

The lap-doubler is for the purpose of laying the slivers from the "breaker" side by side and forming them into a lap to supply the "finisher" card. Twenty-four cans containing the slivers are arranged on one side of the machine, each end passes through a guide provided with a self-stopping motion, so that in case any sliver should break the machine is stopped, and waste or spoiled work is prevented. The slivers then pass side by side between two pairs of calender rollers; and the lap thus formed is wound on a light wooden bobbin placed in the channel between two fluted rollers. Four of

these laps, placed end to end, form a complete lap for the "finisher" card. This machine is fitted with 24 self-stripping flats on Wellmann's system. The fleece is stripped in the usual manner from the doffer by the vibrating comb, and drawn into a sliver, which is deposited in the coiling-can.

In the drawing-frame the fibres of the slivers are straightened and their substance equalised. This machine consists of three pairs of rollers, revolving at different speeds, through which four slivers are drawn into one, and two slivers thus formed are, by passing through a series of rollers, drawn into one; the single sliver thus formed of eight from the carding machine is deposited evenly and compactly in the coiling-can. This machine is fitted with stop motion for stopping the machine should any of the slivers break.

The single slivers are next twisted, for the first time, in the slubbing-frame, into a coarse thread. This frame is of 40 spindles. The slivers are passed from their cans and through three pairs of rollers, the top ones being covered with leather. The slivers then pass to the spindles arranged in a double row along the front of the machine. Each spindle is fitted at its upper end with a flyer, and the slubbing passes through its hollow arm to the bobbin. The spindle and bobbins revolve at different rates, the speed of the bobbin being gradually reduced as the diameter increases by being filled. This is effected by means of a pair of conical drums. The bobbin is lifted by a rack-and-pinion motion, so as to lay the slubbings on the bobbins in even coils. Two slubbings are next twisted together on the intermediate frame of 72 spindles; these are, in their turn, doubled and twisted into a roving, on the roving-frame of 80 spindles, which are finally spun on the self-acting mule.

"Silk-throwing" machinery.

Messrs. Wegmann and Co. (5), of Baden (Argan), exhibit some well-constructed "silk-throwing" machinery, consisting of winding and cleaning machines for the purpose of winding on bobbins the silk as imported in skeins, and of cleaning the silk at the same time. The skeins are placed upon swifts or reels, the diameter of which can be easily altered to suit the different sizes of the skeins, by sliding out the arms or spokes; the silk is passed between the edges of steel cleaners, consisting of a slit between two steel bars, which is adjustable by screws, to pass the maximum thickness allowed, and to stop fibre of extra thickness. The silk is wound on bobbins, driven by friction of light iron pullies, and is traversed on them by means of a slide rod, having an alternate motion, and carrying small glass rings, through which the silk is guided to the bobbins.

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Other machinery.

The fibres of silk are next wound and laid evenly together in the doubling machine previously to their being twisted together in the throwing machine.

Two throwing-machines are exhibited, one for spinning warp and the other weft; also a machine for spinning sewing silk. All these machines are provided with a self-stopping arrangement, in case of breakage of threads.

Some good samples of card-clothing are exhibited by the Fabriques Mécaniques, of Ruti, Zurich (3).

M. Honegger (6), of Wetzikon (Zurich), shows various parts of spinning machinery, such as spindles, flyers, &c.

Spain, &c.

## Spain, Portugal, and Greece

make but a poor show in this class, and exhibit only a few rude spinning-machines and samples of cordage.

Sweden and Denmark.

Cordage.

## Sweden and Denmark

show excellent samples of cordage from the Etablissement de la Marine, at Carlskrona (1), Messrs. Hoffman and Co. (2), of Stockholm, Messrs. Holm and Son, of Copenhagen (1), and M. Thrane and Co. (2) of the same place.

Russia.

Ropes and cables.

## Russia.

Some excellent samples of rope and cables are exhibited by M. Cazalet, of St. Petersburg (1); the Dockyard of Cronstadt (2); Jouravleff of Rybuisk (3); and the Auxiliary Committee of the Caucase, at Tiflis (6), who send specimens of rope and cordage made from bass fibres, wool, and wild hemp.

Italy.

## Italy.

Although the cotton trade is daily becoming more developed in this country, it is a matter of surprise that no preparing or spinning machinery is exhibited.

Ropemaking by machinery in Italy has made but little progress, and the old-fashioned wheels are still used for spinning the yarn and twisting the strands. The combing and preparing of flax and hemp is chiefly performed by hand.

Some well-made machines for winding the silk off from the cocoons, with the usual basins for hot water heated by steam, is exhibited by Messrs. Cariboni (4) of Como; Bataglia, of Varese (5); and Messrs. Traverso, of Allessandria (1).

## Turkey and Egypt.

The specimens of rope and cordage and a few spinning implements of rude construction do not require any particular comment.

## United States of America.



Saw-gins.

The contributions from the United States are rather scanty, and consist entirely of preparing machinery for cotton and wool, for which no particular novelty can be claimed.

Mr. H. L. Emery, of Albany, New York (4 and 6), exhibits two saw-gins of similar construction, the small one being worked by hand. In this machine the circular saws are mounted, about an inch apart, on a cylinder, and project about half an inch through a grate in the hopper, or box where the cotton is fed in. In the hopper is a light wooden shaft thickly studded with pointed wooden teeth, revolving freely, for the purpose of presenting the cotton to the action of the saws without pressing; a brush cylinder revolving in a contrary direction clears the saws, and at the same time creates a strong draught. Across the discharging side of the gin is placed a large revolving cylinder of perforated zinc through which the current of air caused by the brush cylinder passes, carrying with it the dust which passes out at the ends. The cotton deposited on the cylinder is stripped by means of a pair of delivery rollers.

The Southern Cotton Gin Company, of Bridgewater, Massachusetts (5), exhibit a 60-saw gin, with brush cylinder.

A somewhat similar machine is exhibited by Messrs. Bates, Hyde, and Co. (2), of Bridgewater, Massachusetts, worked by hand.

"Burring-pickers."

Mr. Goddard (3), of New York, exhibits a "Mestizo burring-picker," in which the wool is shaken and beaten till all the burrs fall away. The wool is fed in on an endless lattice, between two taker-in rollers, covered with hooked-shaped teeth, to the beater cylinder, covered with bars armed with small teeth, making about 400 revolutions per minute. The wool is then delivered to a smaller cylinder, covered with Garnet's cards, making about 550 revolutions per minute. The wool is stripped from the burring-cylinder by a brush roller revolving at the rate of 900 turns per minute; and the fleece is oiled by a revolving brush upon which oil is constantly dropped. The dust is extracted from the wool through the perforated zinc casing over the cylinder by means of an exhausting fan draught. The production of this machine is stated to be about 1,000 lb. per day.

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Great Britain.

Cotton and wool machinery.

## Great Britain.

Messrs. Platt and Co., of Oldham (15), exhibit a complete set of machinery for preparing and spinning cotton and wool. For the purpose of separating the staple from the seed they use the Macarthy gin, the principal feature in which is a roller from 4 in. to 5 in. in diameter, built up of the fibres of jute, in the same way as a brush, and compressed in such a manner as to nearly resemble pasteboard. This roller revolves in front of a hopper, into which the cotton to be cleaned is thrown; the bottom of the hopper is a grating sloping towards the roller, in front of which is placed a thin steel plate, pressing gently against it. The fibres of the cotton are seized and drawn under this plate by the revolving action of the roller until the seeds come in contact with it. A vibrating knife then ascends, and, passing the edge of the plate, pushes off the seeds, which drop through the grating, and the fibres, thus freed, are delivered on the other side.

The cotton is then spread upon the endless feed-table of the scutching machine, where it is opened, and freed to some extent of dirt, by a beater revolving in a casing fitted with a series of parallel blades, and with longitudinal slits between the blades through which the dust falls. The cotton then passes to a series of cylinders covered with wire gauze, through which the dust is drawn by the partial exhaustion of the air inside, by means of a fan. The cotton is stripped from these cylinders by iron rollers, and formed into a "lap," and partially felted, by being passed between two pairs of calender rollers.

Two carding-machines are exhibited by this firm, one with 45½-in. cylinder, with six pairs of working rollers, and adapted as a single carder for coarse numbers, or as a "breaker," for preparing slivers for the "finisher."

The other has a cylinder of the same diameter, and is fitted with a pair of working rollers and an endless chain of self-stripping flats. It is specially adapted as a "finisher" for cotton of fine numbers.

A combing machine is also shown, for laps of cotton 16 in. in width; the tuft of cotton from the lap placed at the top of the machine is taken by a pair of nipping jaws and held against a rovolving comb, which combs out the short fibres; both ends of the tufts are combed and deposited on a doffing-cylinder, in such a manner as the ends are made to overlap each other, and are reunited in a continuous sliver which is afterwards deposited in a coiling-can on one side of the machine.

The drawing, slubbing, and roving frames of these makers are of excellent construction, and are fitted with the latest improvements.

Two self-acting mules, one for spinning cotton and the other wool, are shown at work. These machines are of the most improved construction, the cam-shaft is driven by conical frictional pulleys, a patent governor or cop-regulator is attached for the purpose of adjusting the winding-on motion to the form of the cop, and it is perfectly automatic in its action. The drawing-out motion is provided with an arrangement for stopping, in case of obstruction to the free traverse of the carriage, thereby preventing breakage of bands and other damage to the machinery.

In the throstle frame exhibited by this firm the common flyer is replaced by the ring and follower. More yarn is produced by this machine with a smaller number of spindles than by the mule, as they can be driven with a greater speed, but the twist is not so regular.

Flax machinery.

Messrs. Lawson and Sons, of Leeds (11), exhibit some highly important machinery for the preparation and spinning of flax. The carding machine is of considerable weight and importance; the main cylinder, or swift, as it is sometimes called, being 5 ft. in diameter and 6 ft. in width, and is surrounded for the greater part of its circumference by working rollers. The tow is supplied on an endless feed-lattice, and is stripped from the main cylinder by three doffing-rollers, each furnished with stripping-combs, and the three slivers thus formed pass to their respective coiling-cans.

The other machines connected with the preparation of flax consist in drawing-frame, spreader, roving-frame of 72 spindles, and a spinning-frame of 200 spindles. These are all of excellent workmanship and design.

Messrs. Combe and Co. (5), of Belfast, also exhibit some good flax machinery, consisting of hackling-machine, roving-frame of 50 spindles, and yarn-reels for winding off lengths of yarn.

The sheets of the hackling machine are vertical, and the hackle-stocks are fixed on the sheets instead of on bars, as is generally the case, and in this way they run more lightly and with less noise and vibration.

The principal feature in the roving-frame is the use of the expanding pulley in place of the conical drum for varying the speed of the bobbin as the yarn is being wound on. This ingenious contrivance for obtaining a variable speed is the invention of Mr. Combe, and consists of two interlocking cones, with the driving-strap running in the groove so formed. An arrangement of left and right handed screws parts or

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brings together the cones, thereby varying the diameter of the working groove, and, consequently, the speed of the bobbins; and a steadier motion is obtained than with the conical pulley, a matter of great importance in twisting the long fibres of flax slivers.

Winding and reeling machinery.

Messrs. Wren and Hopkinson, of Manchester (17), show some highly-ingenious machinery for winding sewing-silk on cards, and for reeling cotton.

Wool-carding machinery.

Mr. Ferraber (7), of Gloucester, exhibits his patent and improved wool-carding machinery, applied to a set of two carding machines constructed by Mr. Tatham, of Rochdale. The fleece, being stripped in the usual manner from the doffer of the "scribbler," is taken by a system of travelling-aprons, one working at right angles to the other; the fleece by this means is deposited in diagonal folds, crossing each other alternately on an endless apron working at right angles to the axis of the machine, and forming a continuous narrow band about 12 in. in width, which is carried forward mechanically and laid, without stretching, in diagonal folds, one overlapping the other, in a continuous and uniform "bat" of the required thickness, on the endless feed-lattice of the "condenser," where the fleece is divided into a series of parallel strips, which are slightly felted in their passage between two endless leather aprons having an alternate motion across them. The threads are then wound on rollers.

## Report on Apparatus and Processes used in Weaving. — (Class 56.) — By Peter Le Neve Foster, Jun., Esq., C.E.



The art of weaving may be traced back to the most remote periods. From allusions made to it in the Bible, there is no doubt that it was practised soon after the Flood. Egypt was probably the early seat of linen weaving, as is proved by the paintings on the ancient monuments, representing the gathering, spinning, and weaving of flax into cloth. Cotton weaving was probably carried on by the Egyptians at the same time. The sacred books of India show that cotton weaving was also carried on in that country from about the time of the Flood. The Chinese date the use of the loom from about the same period in their ancient historical works.

Antiquity of the art of weaving.

The manufacture of cloth by the use of the loom was thus practised and spread abroad in ancient times throughout all Asia. From Egypt and Asia Minor the art of weaving passed, long before the age of Homer, into Greece, and thence, along the shores of the Mediterranean, into Italy and Spain. Probably by way of Constantinople, it spread over Illyria, Dalmatia, and the German tribes, and, descending the Rhine, reached the Low Countries and France. By the Flemings weaving was brought over and firmly settled in England, and finally reached Scotland and Ireland.

Weaving may be defined as "the interlacing together of "two lines of thread at right angles to each other," and the process by which this is effected consists of three distinct movements, which are performed in succession. The first is the shedding of the warp, consisting of the raising of a certain number of the warp threads by means of the treddles, so as to open a passage for the shuttle, which is made to traverse the warp in the second operation, and leaves behind it a shoot of weft. The third operation is the striking home of the shot by the reed. All the improvements that have been made in weaving up to the present time are but expedients for facilitating these three operations.

Definition.

Within the last century the rude and hitherto almost unchanged old loom has been made the subject of surprising improvements, and has been for plain goods more than doubled, and for fancy articles more than quadrupled, in its power and speed of production.

The invention of power weaving is due to Dr. Cartwright, whose first patent is dated April 4, 1785. Previous to the

Power loom.

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invention of the power-loom the treddles were acted on by the feet of the weaver for raising the warp threads to form the shed for the passage of the shuttle. By a reverse action the upper part of the warp threads is lowered and the lower part raised, and the shuttle is made to traverse, and the interlacing is again effected, and in this manner the desired fabric is produced.

Such is the operation of plain weaving; and it will be easily understood that if the warp threads are not raised and depressed in this alternate order of succession a plain and uniform surface will no longer be produced. Thus, in a twill the weft threads do not pass over and under the warp threads in regular succession, but pass over one and under two, or over one and under three, over one and under six or eight, according to the kind of twill that may be required. The effect of this is to produce a kind of diagonal ribbed appearance, either on the right or wrong side of the cloth, and a smooth glossy surface on the other, according as the one thread is crossed above or below by the weft. In order to allow the weft to pass under two, three, four, or more warp threads at once, an arrangement is adopted by which the weaver can, by the action of his foot, raise and depress the warp threads in groups, and in the order of succession required for the particular twill he desires. By the various combinations among the treddles, he produces many varieties of movements which give rise to the different kinds of twills. When in addition to or instead of a twill, flowers, sprigs, spots or any kind of figure is required, an amount of complexity then arises which cannot be got over by any manageable number of treddles. The weft may at one width of the cloth pass over one and under two, over five and under three at another, and so on, according to the part of the figure that may happen to occur at that particular part of the width of the cloth. The next weft would pass over and under in a different order, and hence the warp threads would have to be raised and depressed in a continually varying order; and to effect this, the number of treddles would have to be considerably increased, and would become too numerous to be contained in the loom and for the feet of the weaver to move.

Draw-loom.

Many inventions were conceived to overcome this difficulty, amongst which is the draw-loom, in which strings were so arranged that a boy by drawing them could raise the requisite warp threads and form the shed for the passage of the shuttle. None of these were thoroughly successful

Jacquard looms.

until M. Jacquard, of Lyons, by the particular and most ingenious mechanism known by his name, substituted an

automatic mechanical action in place of the boy, who by pulling certain handles raised the necessary warp threads. This invention is too well known and has been described in so many other places to need an explanation here. The Jacquard loom has completely superseded every other description of apparatus for producing figured work in the loom, and is now applied to the power-loom for carpet weaving and for lace making. Numerous improvements have been made from time to time in the detail, but the machine is essentially the same as that invented by M. Jacquard.

## France.



Various inventions have been made for the purpose of substituting paper for the more expensive cards. One of the best is that of M. Pinel de Granchamp, of Paris, who uses a continuous sheet of thin paper, and has adapted his apparatus to a loom for weaving shawls. This arrangement, compared with the old system, leaves it so immeasurably behind that it may be safely predicted that in a short time cards will be completely abandoned. In the first place, a saving of from 50 to 80 per cent. is obtained in material, and an economy of space; and in consequence of this change a great facility is obtained in pricking out the designs, for the simple reason that, the paper being thinner than card, many leaves can be perforated at the same time; the workmen employed in this labour are also less fatigued, as the implements used in this process are of less weight. In this machine the cylinder is made to revolve continuously, and the feelers as they approach and recede point to the centre of the cylinder.

M. Junot, of Paris, likewise exhibits a jacquard, in which he substitutes paper for cards; but instead of using a continuous sheet the pieces of paper, perforated to the required pattern, are jointed loosely at their edges, and form an endless chain, in the same manner as the cards.

A Jacquard loom for weaving figured silk goods is exhibited by M. Rouze, of Lyons. In this apparatus the griff bars are moveable, and are worked by a separate set of cards, so that all the wires can be thrown off a bar at the same time, each wire being connected with two warp threads. In this manner a pattern may be woven with half the number of cards which would be required if the ordinary jacquard were used.

Several other modifications of the Jacquard are likewise shown, but are not of any practical importance.

Mr. Le Neve Foster, Jun., on Apparatus, &c. used in Weaving.

M. Payen Boudouin, of St. Quentin, shows a good hand-loom for weaving muslins for curtains, &c., with figured borders. The groundwork of the fabric is formed in the usual manner by the traverse of the shuttle, and the figured designs on each side by two shuttles that are made to traverse from the side to a shuttle-box on the middle of the reed; the warp threads are raised and depressed to form the design by an ordinary jacquard. A considerable economy in material used is effected, as the quantity of weft thread to be cut away is much less than if the shuttle for producing the design traversed the whole width of the fabric.

M. Joyot, of Paris, exhibits a Jacquard loom for weaving velvet ribbons. The motions for inserting, withdrawing, and transferring the wires is highly ingenious and automatic. This loom is adapted for weaving six ribbons at once.

Power looms.

M. Mercier, of Louviers, is one of the principal exhibitors of power-looms, of which he exhibits five, adapted for plain goods, flannels, linen, and dress goods. All these machines are of excellent construction, but do not present any novelty in design.

M. Eugene Lacroix, of Rouen, also shows some good power-looms of great width, for weaving heavy goods.

Hosiery.

The production of hosiery holds a high rank in France, as indicated by the amount of transactions of which it forms the basis, as well as the great number of workpeople directly and indirectly employed in weaving, seaming, embroidering, and finishing this class of article.

The district round Troyes may be likened to that of Nottingham, as being the seat of the cotton hosiery manufacture. The silk hosiery of France is manufactured chiefly round Nismes, and in the Department du Gard. Paris and its environs are celebrated for fancy goods; these goods are chiefly remarkable for their originality of pattern, harmonious combinations of colour, and excellent fabrication. The plain and open-work embroidered white silk hose made in France are unrivalled in brilliancy and taste.

Hosiery machinery.

The machinery used for the production of hosiery is quite different from that employed in ordinary weaving, and appears at first sight to be extremely complicated; however, it consists merely of a repetition of parts, easily understood with a moderate degree of attention, provided that an accurate idea is first formed of the nature of the hosiery fabric. The texture is totally different from that of cloth, where the warp and weft threads are interlaced with each other at right angles. One continuous thread only is employed in the construction of the web, so that there is therefore neither warp nor weft. The web may either be produced round, as

in a stocking, and widened or narrowed at pleasure, or in a straight line of any desired width, with a perfect selvage on each side. Simple patterns are easily made by looping in different ways, and variegated designs by the introduction of additional colours. This tissue is perfectly elastic, a quality which specially renders it useful; it can be extended without permanent enlargement or distortion of shape, and consequently adjusts itself with ease to the size of any part of the body for which it has been made, and on which it is worn, and, when drawn off, returns to its former state. It has, however, one disadvantage; if the thread be broken or left loose the whole tissue may be unrove, or it may unrove itself by pressure, loop by loop, with great rapidity. Hence the importance of a strong even yarn or thread and sound make.

The hosiery machinery exhibited by M. Tailbouis, of St. Just-en-Chaussée, are equal to perhaps any in either England or France, and he has introduced into them modifications which adapt them for the production of articles specially suited to French demand. M. Tailbouis exhibits a rectilinear loom, by which from four to eight stockings can be woven in the frame at the same time; the narrowing is performed automatically, and the needles are supported by bars.

Stocking frames.

M. Emanuel Buxtorf, of Troyes, has introduced some important improvements in his circular stocking-frames, the most ingenious of which is the use of a pressure-wheel which varies in circumference so as to act on the required needles, and reverse or form longer loops. Various combinations of these pressure wheels are used so as to produce figures on the web at any required distance apart. A bell apparatus is also attached to these machines for the purpose of making known the number of rows that have been woven.

Messrs. Berthelot and Co., of Troyes, show several stocking-frames which present some features of novelty. Some of these frames are circular and some rectilinear; and one main point of superiority claimed is that, by the substitution of a segment of a large circle for the small wheel which governs the action of the needles, the thread is exposed to a less rapid change of direction, in consequence of which it is less liable to breakage, especially in the case of fine yarns In two of the circular looms of these makers arrangements are introduced, in case of the breakage of a thread, for stopping the machine, and for ringing a bell by electricity.

In the electrical arrangement, each thread, proceeding from its bobbin to the machine, passes through an eye at the end of a very slight wire lever. The thread sustains the lever in the right position as long as it remains unbroken;

Mr. Le Neve Foster, Jun., on Apparatus, &c. used in Weaving.

but, as soon as a breakage occurs, the slender lever falls down upon another metallic surface, and in this manner an electrical contact is established and the bell is rung.

In the other machine the stoppage is effected by mechanical means. A slender lever is sustained in its position by the thread, as before, and this lever in its turn sustains a strong piece of flat iron, which, when let down, encounters projecting pins on the top of the machine, by means of which a clutch situated on the driving-shaft is thrown out of gear, and the machine in consequence stopped.

In the flat machine there is a self-acting arrangement for reducing the width of the fabric as the machine proceeds. A lever, carrying eight points or needles, arranged horizontally, facing the eight hooks at the extreme end of the loom, is so regulated by suitable mechanism that, after a certain number of loops have been woven, the points penetrate the loops on the end needles, withdraw them, and transfer them to the needles immediately adjoining, whereby these last needles have each two loops instead of one, and the width of the fabric is reduced accordingly. These occasional transfers are accomplished by the aid of a wheel rotating beneath the machine, and provided at intervals with suitable projections. This wheel advances one tooth for each stroke of the loom, and it is only after a certain number of teeth have thus been passed that one of the projections comes in contact with a lever communicating with the transferring points, and imparts a suitable motion to it. The flat frame is driven by a double-hand crank in front of the machine.

Messrs. Radiquet and Lecène, of Paris, exhibit several circular stocking-frames, in which, by aid of electricity, the machine is stopped when a thread breaks, a lever in such a case establishing electrical current, and rendering magnetic a piece of iron which withdraws a detent and stops the machine. A means is also provided for stopping the machine should a hole occur in the web. A small wheel revolves inside and another outside the web, immediately below the knitting plane; conduction from one of these wheels to the other is prevented by the intervening web, unless a hole should occur, when contact immediately takes place between these two wheels, and the machine is stopped. A similar result ensues if a stitch should be dropped, as in such an event the needle, by falling below the knitting plane, will in its rotation come in contact with a brass plate placed close below the needle-frame; the needle and plate by this form an electrical current, by means of which a bell is rung, and continues ringing until the machine is set in motion again.

Messrs. Schneider, Legrand, Martinot, and Co., of Sedan,

Ardennes, show a machine for calendering or preparing cottons or linens for the calico printer, in which the fibrous down is removed from the surface of the cloth by passing the piece rapidly over the surface of a series of steel plates with small teeth; these blades act in the same manner as saws, and have a backward and forward motion across the piece, which is drawn over them at the rate of 450 yards per hour. The first blades have 30 teeth to the inch and the finishing blades 40 teeth to the inch. The same firm also exhibit a shearing machine and a teaseling machine for cloths and woollens.

Calendering machine.

M. Nos d'Argence, of Rouen, substitutes in his teaseling machines rotary cards of metallic wires to represent the points of the teasel. The employment of these machines has been attended with highly successful results.

Teaseling machine.

A highly ingenious machine for weaving fishing nets is exhibited by Messrs. Jouanin and Co., of Paris, and seems likely to come into general use in France and England. In this machine the bobbins containing the warps are placed in a frame at the back of the machine, and correspond with the number of meshes in the width of the net; the warp passes over guide pullies, so arranged as to keep the threads in a horizontal line, to a roller, round which it makes one turn at the front of the machine. In the interval between the guide rollers and the front roller is a sinker, formed of a horizontal bar, carried by two levers on a rocking shaft, and so counterbalanced as to take up any slack in the warp thread, and yet to rise when the threads are pulled very tight, as is done in a certain part of the knotting process. The loops of the warp are engaged by a row of horizontal hooks, each of which works on its axis by means of a long rack. The weft threads, which are contained in a row of a kind of shuttles placed in front of the machine, are passed through the loops previously formed in the warp, and in this manner the knot is formed, each shuttle being so guided by the frame with which it is moved as to form its proper knot and mesh. This machine works with such precision that the thread is never frayed, and the knot or the mesh is never too tight. This may be considered an advantage for the operation of tanning, the liquid being able to soak in more readily. The speed of this machine is 12 revolutions per minute, which would give 7,920 rows of knots in a day of 11 hours, if the machine were not stopped for the refilling the spools in the shuttles.

Weaving machine.

M. Thomine exhibits a machine for weaving fishing nets, not only on the same principle as the last, but seemingly a copy of it. From some imperfections in the workmanship, it has not been working very satisfactorily.

## Belgium.

Belgium.

The Belgian department is chiefly remarkable for the excellence of the spiral cutters for cloth-cropping machines, or *tondeuses*. These cutters are of different construction to those employed in France, the blades being attached at the ends by screws to the rollers instead of being brazed into spiral grooves on the cylinder. By this means they can be tempered more easily than in the other way.

Spiral cutters, &c.

The principal exhibitors of spiral cutters and other blades for shearing machines are Messrs. Debial & Co., of Verviers; the Exposition Collective des Mécaniciens Constructeurs de l'Arrondissement de Verviers; and Messrs. Houget and Teston, of Verviers, who exhibit, besides a fulling machine (in which the usual weights are replaced by springs), a shearing machine, and a teaseling machine.

A Jacquard carpet loom is exhibited by the "Société de la Manufacture Royale de Tapis de Tournai." The motions for withdrawing, transferring, and inserting the wires are automatic.

## Prussia.

Prussia.

Shearing machines.

The best shearing machines in the whole Exhibition are those of M. Thomas, of Berlin. They are well and strongly constructed, and are fitted with various appliances and means of adjustment, which are of the utmost importance, as a piece of cloth is easily cut and destroyed if the machine be unskilfully handled.

Some good teaseling machines are exhibited by M. Moser, of Aix-la-Chapelle, and some good power-looms for weaving broad cloth by M. Schnænherr, of Chemnitz.

## Austria.

Austria.

M. W. Schram, of Vienna, exhibits a single acting Jacquard loom, in which the second motion is dispensed with; it has wooden sticks in place of metallic wires, which naturally adds to its bulk. It is well made, and cheap.

## Switzerland.

Switzerland.

M. C. Honnegger, of Ruti, Zurich, exhibits some well-made power-looms for silk weaving of narrow widths; they do not, however, present any novelty in design.

## Italy.

Italy.

Most of the great centres of manufacturing industry in Italy possess hand-looms of every sort for weaving silk, flax, cotton, and hemp; but the manufactories of weaving ma-

chinery are seldom of great importance, as they only employ a small number of workmen.

In the silk manufacture many improvements have been introduced in the implements employed. Amongst these improvements must be mentioned the electric loom of M. Bonelli, of Turin, which was exhibited in England in 1862. This ingenious machine does not seem to have come into use from some inexplicable reason, either from the expense of adapting it to the Jacquard loom at present in use, or from a dislike (arising from ignorance) on the part of manufacturers to a use of electricity.

Silk manufacture.

Electric loom.

The special object of M. Bonelli's machine is to dispense with the Jacquard cards used to produce the required design —a source of considerable expense, more especially in patterns of any extent and variety of treatment; and for this purpose an endless band of paper of suitable width, covered with tin-foil is used. On this metallic surface the required pattern is painted with a brush in black varnish, rendering the parts thus covered non-conducting to a current of electricity. This continuous sheet of paper passes under a series of thin metal teeth, each of which is in connection with a small electro-magnet, and as the band passes under these teeth a current of electricity may be made to pass through such of the teeth as rest on the metallic portion of the band, and from the teeth through the respective coils surrounding small bars of soft iron, and render them temporary magnets, whilst no current passes through those connected with the teeth resting on the parts covered with varnish. Thus, at every shift of the band, each electro-magnet in connection with the teeth becomes active or remains inactive, according to the varying portion of the pattern which happens to be in contact with the teeth. These withdraw, when magnetised, small rods respectively opposite them, which close holes in a plate in front of the frame, and this plate acts the part of the Jacquard card, and is suitable for receiving the steel needles which govern the hooks of the Jacquard in connection with the warp threads as ordinarily used. Each shift of the pattern opens a different series of holes in the plate, which becomes a sort of universal Jacquard card, changing its face at each contact according to the requirements of the pattern.

M. Cambiaso, of Genoa, shows a circular stocking frame of the ordinary construction.

## United States.

United States.

An ingenious and effective power-loom for weaving a convex surface is exhibited by Mr. Opper, superintendent of the Convex Weaving Company of New York, and seems to

Power-loom.

Mr. Le Neve Foster, Jun., on Apparatus, &c. used in Weaving.

answer all the purposes of the hand-loom hitherto exclusively used. It also possesses the advantage, which in a country where labour is scarce is of the greatest importance, of doing ten times the amount of work in the same space of time. With the hand-loom a man can make at the utmost only four pairs of stays in a day, while the convex weaving machine turns out daily upwards of forty pairs.

The superior lightness and flexibility of woven stays, and their perfect freedom from hard seams, have to a very large extent increased the demand for this class of goods.

The principle of a constant length of travel for the shuttle is adopted for the sake of simplicity; but as it is necessary in weaving the gores that the weft thread should pass through only a part of the breadth of the warp, the Jacquard has been employed for the purpose of taking up the portion of the warp required to be woven in that part. As the shuttle always passes over the full breadth of the warp, of which only one portion—say, one-third—is to be used, it unwinds the full length of weft thread from the bobbin, but only a third of it is tied in the warp. In repassing the shuttle one-third more is tied, thus leaving one-third of the unemployed weft thread in the form of a loop upon the article manufactured.

This superfluous thread is removed by the thread-catcher, which is a lever with an elastic finger passing from behind, through the lay on each side of the reed, and pulls the thread out. In consequence of this partial opening of the warp, the fly-shuttle could not be used, and another contrivance had to be resorted to. This consists in a carrier, by which the shuttle is carried to the centre of the warp, when it is taken by another carrier and passed through the warp. In this manner a very even motion, free from all sudden jerks, is imparted to the shuttle, so that the finest silk and the loosest wool can be worked with this lay as neatly and easily as by hand, without the least danger of breaking the thread, as might happen with the fly-shuttle.

The most difficult part of the work is accomplished by the regulator, or take-up motion, the action of which is to take up the cloth as it is woven in such a manner as to leave a straight line in front of the reed. As the cloth is woven first only on one side; secondly, for the whalebone pockets, evenly over the full breadth; thirdly, on the other side only; and, finally, for the full breadth at the back and front of the stay, the motion of the regulator must change accordingly. To effect this, the cloth passes between two sets of rollers, the upper of which are simple pressure rollers, to be regulated by springs and set screws. The lower are fluted, and worked

by a system of levers independent of each other. The levers are worked conjointly by the Jacquard and lay, so that the lay gives only a movement to those levers which have been previously acted upon by the Jacquard.

A very elastic warp tension is obtained by a particularly-constructed lever, combined with an elastic brake, so as to render the whole machine fit for any kind of work, flat or convex, plain or richly ornamented, according to the cards placed upon the Jacquard, and the material put in warp and shuttle.

A good fancy loom is exhibited by Mr. Crompton, of Worcester, Massachusetts, for weaving cloth of extra width.

## Great Britain.

Great Britain.

Weaving machinery has been brought to a high degree of excellence in Great Britain, and its power of production is greatly increased by the improvements that are constantly being made in the various parts of machinery, rendering it more perfect and self-acting.

Beaming frame.

Messrs. Howard and Bullough, of Accrington, near Manchester, exhibit a self-stopping beaming frame, in which each warp thread passes through an eye at the end of a slight wire lever; and in case of the breakage of a thread the lever falls and acts upon a catch which stops the machine; it is therefore impossible to produce bad work.

The same firm exhibits a self-changing shuttle loom, with twelve shuttles. When the weft breaks or is used up in the working shuttle it is thrown out, and another takes its place, and so on till all the shuttles are used up.

Looms.

The principal exhibitors of looms are Messrs. Leeming, of Bradford; Messrs. Hodgson, of Bradford; Messrs. Parker and Sons, of Dundee, whose sailcloth and other looms are well known; Messrs. Smith Brothers, of Keighley; Messrs. Urquhart, Lindsay, and Co., of Dundee; Messrs. Sowden and Stephenson, of Bradford—the looms by these makers are so well known as not to require any particular comment. Messrs. Platt Brothers, of Oldham, show a power-loom for weaving plain and woollen cloths, fitted with reversing motion for unweaving without throwing the shuttle out of the box.

Knitting machine.

Messrs. Cook and Hacking, of Bury, Lancashire, exhibit a self-acting machine designed to knit a perfect heald of any count and any width entirely without hand-labour, and arranged to make either plain or braided edges, with a self-acting stop motion when the yarn breaks or runs out. It makes only a single knot.

## Report on Apparatus and Processes used in the Manufacture of Furniture.—(Class 58.) — By Lieut. Osbert Chadwick, R.E.



The machinery and processes of this class present no great novelties in principle, the chief improvements being in detail and arrangement.

England. In the English section nothing is exhibited; but as there are in class 54 some machines applicable to the processes to be here described, they will be mentioned, so as to afford comparison with those performing similar operations, which in the French section are placed in class 58.

For the same reason some German machines are also included. The following objects are those which will probably be of greatest interest. They are arranged in the order in which they are given in the French general catalogue, as being that by which they are most easily found:—

### France.

France.

Perin: Endless ribbon saws, and specimen of work done by them.

Gèrard: A planing-machine; also circular and reciprocating saws.

Arby: Planing-machine.

Barrère and Caussande: Engraving-machine and copying lathe.

Contamin: Copying lathe.

In the Park.—Cart: Portable saw frame for rough timber, with endless band saws.

### Hesse.

Hesse.

Schmaltz Brothers (54): Machine for shaping pieces for parquet floors.

### America.

America.

Whitney's gauge lathe for legs of chairs, &c.

Whinslow: Double serpentine moulding-machine.

### England.

England.

Worssam: Radial boring-machine; general joiner.

Robinson: Moulding-machine; self-acting cross-cut saw-bench; tenoning machine.

Powis, James, and Co.: Moulding-machine; boring and mortising machine; combined endless and reciprocating sawing-machine.

Saws and sawing machines.

Sawing-machines.—Perin, who was the introducer, if not the inventor, of the endless band saw, shows a fine saw of this kind for cabinetmakers' use. Also a combined reciprocating and band saw machine for inlaying. The endless saw runs over three small pulleys, one of which is provided with an arrangement for tightening the saw. The reciprocating saw works in slides, above and below the table, and is stretched by a spiral spring attached to the upper slide by a leather strap. A small boring-spindle is placed at one side of the table, at the front of which is a vice for holding the saw while being sharpened, during which operation the band saws are placed over two pulleys, provided for the purpose.

M. Perin also shows a fine specimen of the work that can be executed by these saws. Powis, James, and Co. also show a similar machine, but of larger dimensions. In this machine the wood packing round the saw beneath the work is independent of the table, which can therefore be inclined if required without loss of time from having to fit new packing.

M. Cart has a portable saw frame for sawing rough timber, with two endless band saws.

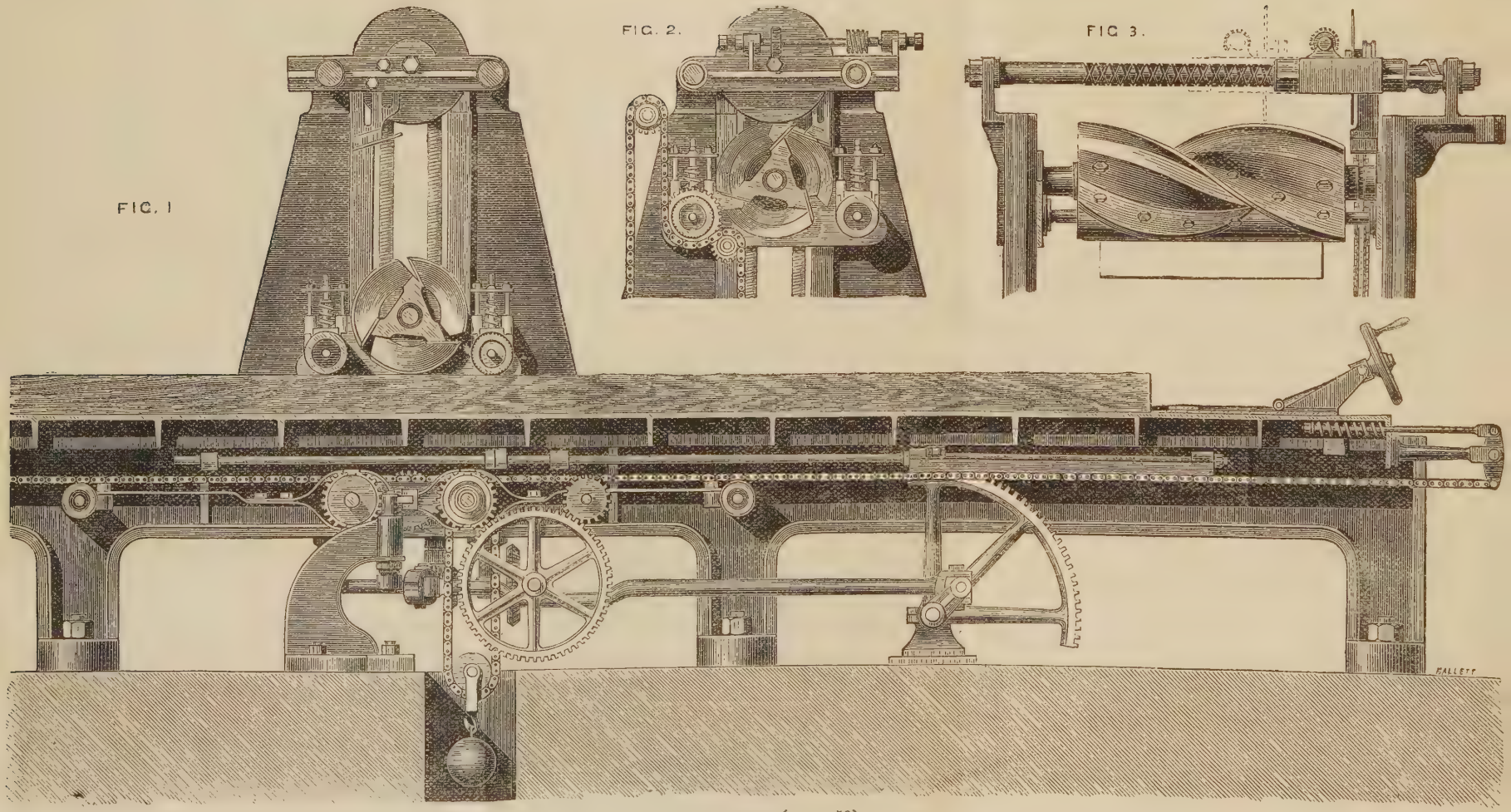
Gèrard shows a small circular saw driven by the foot, which is adapted for all kinds of light work. The table is provided with a slide, with gauges for mitre joints. For rebating, the whole table can be inclined, so that the saw protrudes to any required extent; for bevelling, half the table turns down on a hinge in the prolongation of the saw, and can be fixed at any angle. A sweep-cutting saw is shown by the same exhibitor, the framing of which is entirely of wood. The saw works between arch-heads, and is tightened by a simple lever, which strains the flat chain connecting the opposite ends of the levers which carry the saw. A self-acting crosscut saw by Robinson has an arrangement by which the circular saw moves backwards and forwards in a slit in the table, advancing slowly and returning quickly after making the cut.

Whitney (United States) exhibits a circular saw table, with a crosscut and a ripping saw, so arranged that either can be brought into play without loss of time. The two saws are supported at each end of a lever carried by an axle in the middle of its length. Thus either saw can be brought up through the opening in the table, and the driving-belt is taken up by the pulley of the saw that is uppermost.

FIG. 1

FIG. 2.

FIG 3.




PLANING MACHINE (CLASS 58).

One half the table is made to slide, and is provided with gauges to cut any angle. The other half is fixed, and is provided with a fence.

The circular saws which are provided with apparatus for boring, mortising, &c., will be mentioned afterwards.

Planing and moulding machines.

Planing and Moulding Machine.—In the planing-machine of Arbey the cutters are in the form of a screw; there are three, and each makes rather more than one third of a turn. To ensure the cutters being sharpened to proper form so as to cut a flat surface, a self-acting grindstone is attached to the machine. The stone is carried by a frame which traverses across the machine parallel to the axis of the cutter-block, which is for this purpose disconnected from the driving-pulley. On the lower part of this traversing frame, immediately under the grindstone, is a rest against which the face of the cutting blade is pressed by a weight attached to a pulley on the spindle. The grindstone is moved backwards and forwards across the machine by a screw, while the cutter, from its form, is caused to revolve by the pressure of the rest. In this manner a true helical form is given to the edge. The work is clamped to the table, which moves at the rate of about 12 feet per minute under the cutter. For planing thin boards the table may be fixed, and the feed is then given by a roller.

Gèrard: This planing-machine consists of a vertical disc, pierced with two radial slits, through which the edges of the cutters protrude; they are straight, and exactly similar to an ordinary plane-iron. The work is carried by a table in front of the disc, which revolves at a comparatively slow rate.

The moulding-machine shown by Robinson (class 54) has four cutter spindles, so that the four sides of the work can be finished at one operation. The upper cutter-spindle can be set slanting, so that, for a moulding much deeper at one side, the cutter need not have such a great difference in size between the two ends. The feed-rollers are driven by an endless screw, and, to adjust them for differences in thickness of the work, their axles move in a circular arc, whose centre coincides with the centre of the driving-wheel, so that they are always in gear. In a similar machine by Powis, James, and Co. the cutter spindles for the edges of the board can be inclined at any angle, so as to enable them to tongue and groove the edges of boards for cylindrical work, such as cylinder lagging. In this machine the rate of the feed can be changed even while working. The feed rollers are worked by a friction pulley which presses against the face of a revolving disc. This friction pulley can be moved

along its axle from the centre of the disc to the circumference, or can be removed altogether from contact, so that the rate of feed can be changed to any required extent.

In Whitney's cylinder plane the horizontal cutter spindle is fixed, and the table is raised or lowered to accommodate different thicknesses of plank by a simple arrangement. On the under side of the table is an inclined plane, which rests on a wedge. This wedge is moved in or out by means of a screw; and, as the table cannot move horizontally, it is raised or lowered. One turn of the screw raises the table one eighth of an inch.

Whinslow's double serpentine moulding machine is designed to mould pieces of an irregular curved shape, such as the backs of chairs or sofas. The cutter-spindle is horizontal, and beneath it, and supporting the work, is a fluted roller. The flutes of this roller are slightly oblique, so as to press the work against a stop projecting from the frame. This pressure causes the work in passing under the cutter to follow any outline to which it may originally have been cut. It is pressed down into the fluted roller by two rollers, one on either side of the cutter. The cutter is made up of small irons, each of which is held in undercut grooves in the edges of two rings placed on the spindle, and tightened by a nut. By this means several mouldings can be made with the same irons by changing their relative positions, and the whole is better balanced.

Schmaltz Brothers, Hesse (class 54), exhibit a machine for parquet flooring which may, perhaps, be classed under this head. Its object is to shape, tongue, and groove the edges of the geometrical figures for this kind of floor. The tool is carried by a vertical spindle, and the work is fixed to a circular table, supported by a slide rest. This table also turns on a vertical axle, and can be turned round through 30, 45, 60, or 90 degrees, and then fixed by a stop, which enters into notches in its circumference. By this means accurate hexagons, octagons, &c. are cut, and the edges grooved.

Vanloo, France (5). This machine produces ribbed, beaded, and basket-work patterns of various sorts. A table carrying the wood to be carved moves backwards and forwards under a frame carrying the tool; on each side of this table is a rack, the projections of which act on a sort of cam fixed to the lower side of the frame carrying the tool, causing it to pass over the work with a jumping movement. The form of the cam and the shape to which the edge of the cutter is ground determine the pattern. For some patterns a horizontal movement of the cutter is also required. For this

purpose a rack is fixed on the side of the table, and acts on a cam on the frame, as before. The tool cuts both ways, and the motion of the table is self-acting.

The universal moulding, shaping, and recessing machine of Worssam and Co., England (class 54), is one which may be taken as intermediate between the moulding and the boring machines. The vertical cutter-spindle is carried by a frame which overhangs considerably, so that the work can pass under the tool; and thus it is enabled to work in the centre of a board. For sinking recesses to pattern, a table, carrying the work and pattern, is added, which can be moved by hand in any direction on two slides at right angles to one another. This machine has also a second cutter-spindle, which works below the table, and is brought up by a hand lever. This cutter revolves in an opposite direction to the top one.

Mortising and boring machines.

Mortising and Boring Machines.—Of these machines two kinds are exhibited, one with a revolving cutter and the other with an ordinary mortise chisel with a reciprocating motion. Of the first kind a machine is exhibited by Gèrard. The spindle is horizontal, and can be raised or lowered according to the position of the mortise to be cut. The work is traversed, and the spindle brought up by racks and pinions. To prevent the lever handles being sometimes in an inconvenient position, these pinions are loose on their shafts, and can be slid out of gear with the rack and brought to a more convenient position. In the similar machine of Perin there is a second spindle, parallel to the first, which does not revolve, but carries a double-edged fork-shaped cutter for finishing the ends of the mortise, which are left round by the revolving cutter. Similar machines are exhibited by Schmaltz and Geschwind, and Zimmermann. Of the machines with the reciprocating chisel one is shown by Rogers, United States. The chisel is moved by a crank and connecting-rod; and, with crank-shaft and driving-pulley, is brought down to the work by the pressure of the foot applied to a treaddle, and raised from it by a weight. When the chisel is allowed to rise to the top of its slide it is turned half round by a stud, which strikes a spiral cam, so as to cut the other end of the mortise; a similar cam turns the chisel back again when brought to the bottom of the slide.

Tenoning machines.

Tenoning machines.—Rogers' tenoning machine, United States, has two horizontal cutter-spindles, with open cylindrical cutter-heads, which are provided with a small saw spur to cut the shoulder of the tenon. The table carrying the work is raised or lowered by four wedges. The cutter-spindles have independent horizontal adjustments, so that a tenon of unequal depth on the two sides can be cut if required.

Lieut. Chadwick on the Manufacture of Furniture.

A similar independent adjustment is seen in Robinson's machine.

Other machines.

Machines performing several operations. — Worssam's "general joiner" does sawing, planing, and thicknessing; mortising, tenoning, cross-cutting, and squaring up; tongueing, rabbeting, grooving, moulding, and beading; chamfering, wedge-cutting, and boring. The saw fence can be inclined at any angle, and the table rises and falls, so that any depth of cut may be taken. For planing, a planing disc replaces the saw. Tenons are cut with a double saw, the work being fixed in a clamp which slides along the fence. For grooving, a "drunken saw," or one set obliquely on its spindle, is used. For mortising, boring, or moulding, the tool is fixed on the opposite end of the spindle to the saw, and the work is carried by a sliding plate, working upon a table with an independent rising and falling motion, so that boring can be carried on at the same time as sawing.

A similar motion is shown by C. Powis. Robinson's circular saw bench for tongueing, grooving, boring, cross-cutting, and sawing is somewhat simpler. The saw-spindle rises and falls instead of the table. For grooving, a cutter is employed, replacing the saw. For boring, the auger is attached to the end of the spindle, and the work is carried by a separate table. It is considered better, when expense is not considered, to have a separate machine for mortising, as the motion of the wood in this operation produces a lateral strain on the spindle which is apt to derange it for planing or sawing.

## Various Machines.

Engraving machines.

Barrère et Caussande exhibit a machine for engraving. This machine is chiefly intended to produce and engrave the complex patterns which are used in bank-notes. It engraves circles, ellipses, circular and elliptical rosettes. There is also an apparatus for producing small stars at regular intervals, forming thus the ground for bank-notes. It also engraves automatically from the originals or casts, by the "anaglyptographic" process, medals, &c.

Copying-lathe.

A copying-lathe for medals is also shown by the same exhibitors. In this machine the work and the original revolve slowly, at the same speed. A tracing-point moves slowly from the circumference of the model, so as to describe a spiral track over the surface to be copied, and rises or falls as it meets the elevations or depressions. The vertical motion of this point is communicated to a drill, which moves in a similar manner over the work. Reduction or enlargement is

produced by causing the horizontal movement of the drill to be slower or faster than that of the tracing-point, by means of change-wheels. Contaurin has a similar machine, but the movements are produced entirely by levers.

Gauge-lathe.

Whitney's gauge-lathe finishes at one operation the legs and rounds of chairs, &c. It is a lathe with a slide rest traversed by a screw. This rest carries two tools; one, a chisel, is fixed, and roughs off the work. The second, a V-shaped cutter, cuts out the pattern, and is guided by a template fixed to the bed of the lathe. A knife, whose edge is moulded to the form to be produced, moves vertically in a frame behind the lathe, as the slide-rest passes along, this knife descends and smooths off the pattern produced by the first two cutters. In this manner chair legs are produced from a rough square bar with an accuracy equal to that attained by hand, and with immense rapidity.

## Report on Apparatus and Processes used in Paper Making, Dyeing, and Painting.—(Class 59.)—By Captain Fred. Beaumont, R.E.



This class is defined by the French regulations as follows:— General remarks.

Apparatus for printing paperhangings and tissues; machines for engraving; cylinders for printing.

Apparatus for bleaching, and dyeing, and for the preparation of paper and tissues; apparatus for making paper by hand and by machinery; apparatus for embossing, ruling, glazing, and watering paper; machines for cutting out, paring, stamping paper, &c.

Materials, apparatus, and products of typefounding, stereotypes, &c.; machines and apparatus used in typography, stereotyping, copper-plate printing, lithography, authography, chaleography, paniconography, chromolithography, &c.

Printing of postage-stamps.

Machines for setting up and sorting types.

The object of the report which I am now writing is to serve as a guide to such of the English public as may take an interest in class 59, and it is not intended to be a scientific criticism on paper machinery; had such a report been required I should have felt myself incompetent to the task of preparing it. The visitor to the Paris Exhibition of 1867 will have found himself much puzzled in his attempt to study any particular class of machinery, both by reason of inaccuracies in the catalogue, and from the difficulty of finding readily the objects sought for, many of the exhibits having been placed out of the machinery gallery and in the various annexes in the park.

A considerable portion of the French class 59 was in a separate building, which had been established near Messrs. Schneiders' (the Creuzot) exhibition, opposite to the French agricultural gallery. A part of the Belgian exhibition, too, was in their annexe, on the west side of the grand avenue, leading from the Ecole Militaire to the main building.

It is somewhat difficult in writing a report of this nature to draw the line between a mere superficial glance and so much detail as to render it generally uninteresting. I propose to give such a description of the exhibits I have to notice as shall be intelligible to an ordinary inquirer having the subject

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matter in his mind; and I hope, farther, to be able to make my explanations by themselves tolerably clear to those who have some technical knowledge, or, at any rate, sufficiently so to give a general idea of the object alluded to.

I thought at first of attempting to classify the different sorts of machinery together of the various countries; it seemed, however, on consideration, that such an arrangement could not be very readily made, and I shall therefore go straight through the catalogue, taking up those of the exhibits as may be worth noticing in their numerical order, commencing with the French.

Before proceeding to a description of the machinery it may be of assistance to some to give a few general remarks on papermaking machinery and printing-presses. Speaking of the former, there does not appear lately to have been any very notable advance made; nor, indeed, has the system altered, except in some mechanical details, since the introduction of machinery to supersede hand labour, now some sixty years ago.

Paper making.

The manufacture of paper divides itself into two operations —first, the preparation of the pulp from which paper is made; and, secondly, the formation of that pulp into paper.

The pulp is produced originally from rags, or ropes, and old paper, which are dealt with us as follows: The matter is first sorted and dusted, then cut up; afterwards boiled in a boiler under a varying pressure of steam up to as high as 80 lb. on the square inch, broken up and reduced to half-stuff, and then bleached, usually either by chlorine gas or by steep bleaching with chloride of lime; after which it is passed through a rag-engine, the effect of which is to destroy the original character of the material, either as rags or rope, and to reduce it to its elementary fibre in the form of pulp, which is then ready to pass into the hands of the papermaker.

As rags and rope are expensive, it is a desideratum either to find a cheaper substitute or to supplement them by mixing with them more or less off an inferior material. It is difficult to find a pulp made from other matter which can equal in the quality of its fibre that prepared from rag pulp, without which essential desideratum the paper would possess no tenacity. Many substances have been proposed for the above purpose with more or less success, amongst which may be mentioned wood, straw, and some of the foreign grasses, which latter, from their long stringy nature, are more suited than those grown in England. Straw pulp has been extensively employed for the production of a medium description of paper, much used by railway and other companies. There are also some samples of paper in the Exhibition made from wood pulp

only; but hitherto the use of this substance alone has been exceptional. It can, however, be mixed in certain proportions with rag pulp for the manufacture of good paper, and its value under these circumstances is entirely regulated by its cost of production

When the pulp, properly prepared, and of the consistency of soup, comes to the paper-machine proper, it is dealt with as follows:—It is first passed through strainers to remove all knots and impurities, and, being mixed with a sufficient quantity of water, it is delivered in a regular stream on to a travelling wove wire, which, by abstracting the water, gradually causes it to assume the consistency of paper. The water first drips from the pulp, but to assist it the wire is carried over several vacuum boxes, or boxes where a partial vacuum is kept up; after which it leaves the wire and passes on to a felt with which it is pressed between rollers, whence it is taken round drying-cylinders warmed with steam. These cylinders gradually absorb all moisture, and eventually deliver the paper between glazing-rollers, where it is glazed by pressure, and issues ready to be cut up to the size required.

Printing.

There is a very fair collection of printing-presses shown, especially by the French, though, with one exception, there is little novelty of design, the principal differences being in matters of detail.

A printing-press has simply to ensure a sufficient amount of pressure between the type and the paper, to provide that the former be properly inked after each impression, and that the latter can be regularly delivered and taken away. There would appear to be about one rate of speed at which it is found practicable that the paper shall be brought in contact with the type; and after this speed is reached a multiplication of the delivery is made by increasing the number of sets of type employed—or, in other words, making more printing-machines, which can be done by adding to the number of cylinders or by grouping more sets of type round a single larger one. For newspapers, which require a very large number of impressions in a short time, the rate of speed to be got from a single printing-machine is found to be inadequate.

In all the machines exhibited it will be seen generally that the old method of inking the type is preserved—viz., by regulating the flow of ink on to the inking-table by means of a doctor, its equable spreading by rollers, and its transfer, through the medium of other rollers, to the type. There are three descriptions of printing-presses, viz.:—1st, those more or less resembling the hand press, where the pressure is brought to bear directly by means of screws or levers in connection with the type-table; 2nd, those where a cylinder is

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employed to press the paper on the type, the latter being moved horizontally under the former; and, 3rd, those in which, the type being fixed around one cylinder, the paper is passed betwteen it and a second; the two cylinders rolling against each other, with the paper between them. The latter system has much the advantage in point of speed; but it necessitates printing from stereotype blocks, as otherwise there would be peculiar difficulties in fixing the type to the circumference of a cylinder in motion. I believe an attempt has been made to get over the difficulty arising from the centrifugal force developed by the revolving cylinder, by fixing the type internally, but, so far as I know, without practical success.

## France.

Felts and wires.

There are a considerable number of felts shown, all of good quality, but hardly so strong as those made in England; and, though the prices may be somewhat lower, there is not more than a proportionate difference.

The wires are also well made, and will bear a close inspection. Some of them are made with double warp; but this is no novelty, and in what the particular advantage of the arrangement consists it is somewhat difficult to see.

I shall now proceed to notice such exhibits as may present specialties, in their numerical order, according to the French catalogue.

Letang (14) shows a very well-made machine for stamping railway tickets. The general arrangements are somewhat similar to the presses made by M. Lecoq (described hereafter). The numbering apparatus is of the ordinary kind. The price of the press is 2,500f. complete.

Bordes (18) exhibits a printing-cylinder for printing continuous sheets of postage-stamps, by which an economy in cost of 75 per cent. is stated to be obtained over the method of printing ordinarily used. The cylinder has been prepared from a single stamp, which is made by hand to impress its figure, *in relief*, on the copper cylinder; the laborious process of engraving is therefore reduced to a minimum, while the surface which receives the engraving is, as a cylinder, the most convenient for rapid printing. The apparatus requires to be worked from a special press, which, though not exhibited, has been made.

Coblence (19) is one of the earliest persons who applied practically the system of electrotyping. He now shows a good sample, on a large scale, of the process, which may be briefly described as follows:—1st, the engraving is made on wood; 2nd, a cast is taken in some plastic material (M.

Coblence uses gutta-percha); 3rd, copper is deposited by the electrotype process on the cast, which copper becomes a facsimile of the original wood engraving, and which, from its durability, permits of a larger number of impressions, and those of a better and sharper outline, being taken than could be done from the original wood engraving.

Lecoq's stamping and numbering presses.

Lecoq (20) exhibits some well-made presses for stamping and numbering railway tickets and for stamping coupons; indeed, his presses can be adapted to any purposes in connection with stamping, printing, or embossing that may be required. As the arrangement and workmanship of Messrs. Lecoq's presses are unsurpassed by any in the Exhibition, I shall describe them somewhat in detail. The ticket-press will be seen to consist of—1st, a vertical motion, which is taken from a crank on the driving-shaft, and which effects the stamping; 2nd, of an extremely neat self-acting gear for presenting the tickets to the stamp; and, 3rd, of the inking apparatus. The inking is effected by three rollers: the first takes the ink from the pad and places it on a small inking-table, the second spreads it, and a third takes it from the table to the type. This arrangement ensures regularity in the inking.

The rotation numbering is given in a way which will be seen to be common to most presses of this description—viz., by having a series of wheels side by side and whose peripheries are stamped with figures, a self-acting motion causes the first or unit wheel to move regularly forward a step for each stroke of the press, the unit wheel picks up the ten wheel every tenth stroke, and the ten wheel picks up the hundred wheel every tenth of its strokes corresponding to a hundred of the unit wheel. The machine shown can number up to 10,000, it can stamp tickets at the rate of 8,000 or 10,000 per hour, and its price is 3,500f.

M. Lecoq shows also an ingenious machine for putting railway-tickets up in bundles; as also a stamp for paper which varies the pattern by a combination of embossing and printing in colour, which is effected as follows:—The die is made in two pieces, the central portion being withdrawn while the outside is being inked, and replaced before the impression is made; it results that the outside is stamped in colour and the centre of the pattern embossed dry.

Meyer and Co. (21) show a method of fixing rag-engine knives which is novel. The blades are embedded in a matrix of soft metal, which can be cut away as they wear or require sharpening. Blades have before been somewhat similarly fixed by being bolted up between pieces or plates of zinc or brass; the more usual plan, however, is to form the knives

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with bevel edges on their lower parts and then bolt them directly together. It may have been noticed that amongst the exhibits of Messrs. Meyer there is in one instance a peculiarity in the angle at which the knives are set.

Poirier's match-box making machine.

Poirier (24), amongst several well-made presses for various purposes, shows a machine which, though for a small object is well worthy of attention. It is an evidence of how much mechanical ingenuity may do towards lightening human labour when once it is clearly known what is required.

A lucifer match-box is both a simple and cheap thing to make by hand: but as matches are sold in small quantities, and at a very low price, the value of the box plays a certain not unimportant part in the price of the article. By this machine of M. Poirer the boxes are actually stamped complete at the rate of some 2,800 per hour. The action of the machine is as follows:—A rectangular piece of cardboard, of the required form, is taken, with the corners rounded off. This is pressed by a die into an oblong hole, giving it at once a box shape. The corners of the cardboard are not in any way cut, and it is not clear at first to see what becomes of the superabundunt stuff at the angles; the angles are, however, doubled upon the sides, and a sort of cold weld produced by sheer pressure. The machine is fed by hand, but it could easily be made automatic.

There is also a machine for making envelopes shown which is worth attention.

Ducommun (31) has a machine for printing a continuous roll of material, in six colours. The stuff is passed round a central cylinder, about which are grouped impression-cylinders, corresponding to the number of colours to be printed, each roller being provided with a separate inking apparatus. For rough work this method answers well enough, but the colours cannot be so truly laid on as not occasionally to overlap each other.

Gaiffe's electrical engraving machine.

Messrs. Gaiffe (32) exhibit a machine for engraving by electricity, which, though not absolutely new, has been perfected since Messrs. Gaiffe made their first attempt in 1852. There are now some eight machines at work in Manchester for engraving printing-cylinders. The way in which the machine does its work, and the advantages the system appears to possess, are such as to make it one of the most interesting objects in class 59.

A design having been drawn in prepared ink, on a copper-plate, the machine reproduces it engraved on copper, either on the same or a reduced scale, and by multiplying the engraving apparatus any number of copies may be obtained from one labour of copying. The principle of the machine

is as follows:—A dumb tracer is passed over every portion of the original, and, by mechanism to be described hereafter, causes a diamond point to act on the copper-plate on which the engraving is to be produced every time that the said tracer passes over a line of the copy, producing thereby indentations in the copper corresponding with the original. Both the original and the plate have slow synchronous rotary motions, while the dumb tracer and the diamond point have horizontal motions over the surfaces of their respective plates. The diamond is carried by the armature of an electro-magnet, which, while the current is passing, keeps the cutter clear of the plate; but on being released a spring acts and puts the cutter in action. Now, the dumb tracer, the copper-plate of the original, and the electro-magnet form part of an electric circuit; hence, when the first is in contact with the second or, when no engraving has to be done, the electro-magnet keeps the diamond from the plate; and on the circuit being broken, owing to the ink of the original forming a non-conducting medium, the spring reacts and allows the diamond to cut. As the dumb tracer passes in a spiral over the surface of the plate, resulting from the combined motions of the tracer and the plate, it follows that the lines of the copy are not real lines, but a series of dots, which are so close together as to produce the same effect as whole lines. The only continued line that could be traced is a spiral corresponding to the track of the tracer, when this latter, travelling always on the ink, the electric circuit would be kept broken, and a corresponding spiral produced on the copy. By varying the the pitch of the screws carrying the diamond points the copies may be produced on any scale. In the machine exhibited there are several diamonds moving at various rates of speed, and, by a simple engaging apparatus, they may all at will take their motions from each or either of the screws. It will be seen that any number of copies may be taken at one operation if the apparatus be suitably arranged, and that without skilled labour. A second machine is exhibited with the plate laid horizontally. It is shown copying and reducing a military reconnoissance. During the Italian war M. Gaiffe was employed to reproduce the plans of the engineer officers on a smaller scale for the use of the État Major.

By drawing on tinned paper the original sketch may be used, the tin taking the place of the copper-plate as a conductor. But M. Gaiffe stated to me that he was able, by certain means which he did not wish to make public, to take any ordinary ink drawing and transfer it to a copper-plate in such a way as to permit of its being directly engraved

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from. Assuming that the above can be done, the sketches made by the engineers sent into camp over night might be engraved to the desired scale and any number of copies struck off by next morning.

When a large engraving has to be copied, with a view to saving time, two or more diamonds may be employed, each commanding a certain section of work and all working together. The system offers great facilities for economically copying to the same or different scales, and it permits the work of an artist to be reproduced an copper without the necessity of an engraver. The electricity is furnished by a Daniell's battery of three elements.

Each engraving, after it has left the machine, requires to be deepened by acid in the usual way.

A complete apparatus, suitable for a full-sized engraving and furnished with three diamond-cutters, costs 6,000f.

Godchaux's continuous printing-machine.

Messrs. Rebourg (33) show an ordinary well-constructed printing-press, to which is attached a simple and effective apparatus, by Messrs. Tournier (34), for ruling such lines as are required in account-books. It consists of a roller having the required lines raised upon it, and which is kept in contact with the paper before it reaches the ordinary type. The arrangement admits of lines being ruled in two colours —one in black, by the type, and the other red, by the roller. There is pactically a difficulty in setting up lines in the type-box at right angles and crossing each other nicely, which is got over by the above system.

Godchaux (37) shows a machine for printing, on both sides, a continuous roll of paper; it is exhibited printing the leaves of copy books. The machine consists of four cylinders, each pair printing one side of the paper; the paper is taken some distance above the cylinders before it is allowed to come from the first to the second, for the purpose of allowing time for the ink to dry. The process can be aided if need be by artificial heat. The copper cylinders on which the characters are engraved revolve with their lower edges in the ink. A steel blade, to which a lateral motion is given, scrapes off all superfluous ink. There is a cutting-machine attached, which cuts the roll of paper up into proper lengths. This cutter consists of a single blade fixed in a revolving drum, on which are also fastened a series of vanes, the object of which is to keep a current of air playing on the paper, and so cause it to press against the fixed blades, ensuring a clean cut.

Varrall, Elwall, and Poulot (39), who have large workshops in Paris, and who make excellent machines, show, in class 59, one or two machines, which are all well turned out. A casting for a rag-engine, from a hand-made mould, is

worth noticing as an evidence of perfection in th at sorof work.

A machine is also shown, on the design of Messrs. Orioli and Henry, which has for its object to completely reduce any knots or other impurities, that they pretend, under certain circumstances, are inseparable from the pulp if the rag-engine alone be used. It consists of a small horizontal mill, with two bronze discs acting after the fashion of millstones, each one furnished with knives, similar to a rag-engine. The lower disc is kept revolving at some 300 or 400 turns per minute. As an amount of centrifugal force is given to the water and pulp, the apparatus may be put in any convenient position with respect to the paper-machine, since, if below it, the mill will itself deliver at a moderate difference of level. The apparatus may be said to be a varied form of Stuart's pulp-engine, subsequently described.

Messrs. Tulpin (40) exhibit, in the main building, a self-acting valve for regulating and reducing a pressure of steam. It consists of a diaphragm of india-rubber, which acts on a spindle in connexion with a throttle-valve in the supply-pipe, so arranged that when the pressure acting on the diaphragm exceeds a given amount it cuts off the supply. Any sticking, however, of the apparatus would permit an undue accumulation of pressure.

In the annexe in the park Messrs. Tulpin show three machines worthy of notice—one for washing skeins of cotton, which, being hung on rollers, are swung about in a trough of water. The rollers have the following movements:—1st, a lateral motion through the water; 2nd, a rotatory motion; 3rd, a slightly vertical motion. The above arrangement ensures all parts of the fabric being thoroughly acted on.

A well-arranged boiler, heated by steam, should be looked at, which has a very simple and effective system of stirrers attached to it.

Tulpin's drying cylinder.

Lastly, there is an apparatus for drying cloths which differs from the cylinders ordinarily in use by being of much larger diameter. The machine consists of a large wheel, the spokes of which carry the steam to the periphery, which is made of a pair of concentric plates, and forms the drying surface. This arrangement permits of any size of wheel and any pressure of steam being used, since the plates can readily be stayed as required. The cloth is carried by a set of sharp hooks attached to an endless iron chain passing round the cylinder, one set of hooks being fixed, and the other capable of lateral adjustment according to the widths of the cloths. The distances apart of the chains can be regulated while the machine is in motion by a sort of umbrella movement. The

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diameter of the wheel shown is four metres. It has a speed at its circumference of 600 metres per hour, and is furnished with steam at a pressure of three to five atmospheres (45 lb. to 75 lb. on the square inch).

The wheel is made in pieces, so as to be readily transported; and its cost is 7,500f.

Kocher and Houssiaux (41) show a lithographic press which differs from others in that the lithographic stone is cylindrical, in place of being flat. The greatest rate of speed are obtained from cylindrical printing-machines; and Messrs. Kocher and Houssiaux wish to take advantage of the principle for lithographic printing. The machine has been worked, but cannot as yet be said to have passed the experimental stage.

Brisset (49) has a well made ordinary lithographic press, which, when I saw it, was using two colours shaded together on a stone, which produced a very pretty effect in colouring a printed ink-sketch.

Blanchard and Desban (50) exhibit a pentograph which engraves, and, if need be, reduces at the same time, an original design, the latter being passed over by a dumb tracer. This machine does by hand what Messrs. Gaiffe's apparatus does automatically.

Messrs. Boildieu (51) show a complete exhibition of printers' tools: the house is noted as having especially devoted themselves to this branch of business.

Lapeyre (54) shows lithographic stones, and a method of joining broken ones, which he avers is so strong that the stone is thereby rendered practically as good as ever, thus recovering the loss which is incurred when a large stone is broken. The mended stones which are shown look well done; but their value is dependent on their strength, which I had no means of ascertaining.

Moulde and Wibart's double colour printing-press.

Moulde and Wibart (55) offer a press for printing in different colours. As there are several presses for the above purposes shown by different exhibitors, it may be well to describe in a few lines the two methods of producing double-coloured impressions; the first is, by having a separate inking and printing arrangement for each colour, the paper being passed as many times under the press as there are colours; thus, if a chessboard pattern had to be produced, all the black squares would be printed by one set of type, and all the red ones by another; were the border required of a third colour, there would be no difficulty in forming it in the same manner. It is obvious that this method necessitates a very exact register—that is, that each colour should come up exactly to the edge of its neighbour, and not overlap. This is effected

by care in the arrangement of the type, and providing that the position of the paper shall remain absolutely the same during the whole operation. But with all care, it is very difficult in this manner to produce quite perfect impressions.

There is no example in the Exhibition of the other method of printing in different colours; but printing-presses on this principle have been made for many years by Messrs. Bryan Donkin, of London, who have supplied them to banks for printing bank-notes, the difference of colour presenting a great obstacle to the notes being forged. By Messrs. Bryan Donkin's method the type is divided into as many portions as there are colours, one portion falling away from the rest, each is inked separately of the required colour, and, the type being rejoined, the impression is taken at one operation. By this method all difficulties in connexion with the register are avoided; but no press has yet been made to print in more than two colours.

Messrs. Moulde and Wibart have arranged the printing cylinder between two sets of type, each provided with their separate inking apparatus of the colours required, the impression-cylinder passes over either set of type once, the paper receiving at each operation that part of the impression belonging to the particular colour, and the two together making up the complete print. The press is well made, and an arrngement has been introduced by which all shock to the machinery is avoided at each change of motion, and the moving parts are brought steadily to rest.

Marinoni's lithographic and typographic press.

Marinoni(56) exhibits a press which may be used at pleasure for lithographic or typographic printing. There would appear to be no reason why a press should not be used for both purposes, provided arrangements are made to enable the printing-table to receive either the type-box or the lithographic stones, which are of different thicknesses. This is effected by supporting the press table on screws which admit of vertical adjustment. The reciprocating movement is given to the table by means of a crank, and its movement is kept synchronous with the periphery of the impression roll by the two being geared together by teeth on the roll which take into a rack on the table; the return of the latter is effected without moving the former as a blank is left in the teeth of the roll at the end of its course, a self-acting motion being given to the table to enable the rack to retake in gear on commencing a fresh stroke.

Frédureau and Chavannes' paper cutting and folding machine.

Frédureau and Chavannes (63) show a machine for hand labour in folding and cutting sheets of paper. The details are carefully and mechanically worked out, and the precision with which the machine does its work is remarkable. Without

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a drawing it is impossible to explain properly this machine, but its action is as follows:—A sheet of paper having been presented, it is cut in two; each part is then passed through a narrow slit-like opening, and, a knife being brought against it, it is cut again, and again passed through openings which cause it to be folded. The paper is guided in its course by being held between endless tapes, which are carried round rollers. The tapes may, in fact, be said to take charge of the sheet of paper, and, where a cut is required, to present it to the action of a knife, and, where a fold, to a slit-like opening in a metal plate, a blunt knife forcing it through the latter. The cutting-knives are made serrated, so as to give a drawing cut through the motion of each point in the blade is, while cutting, nearly at right angles to the paper.

It is easy to see that the above principles may be applied to any material requiring folding, but a great deal of ingenuity is needed to make the movements work well together.

Various printing presses by Messrs. Perreau, Gaveaux, and Dutartre.

Perreau and Co. (65) exhibit a press which they state can print 1,200 leaves per hour on both sides. It has two cylinders, and can print from a carte-de-visite up to a sheet of paper 1m. 15c. long by 80c. broad; it is especially adapted for the production of illustrated books where accuracy is required, as great care has been taken to ensure a perfect similarity of motion between the type-table and the outside of the cylinders. The general arrangement of this press is of the ordinary kind; the reciprocating movement is given to the table by a pinion-wheel working alternately above and below a rack attached to the former, somewhat after the fashion in which mangles are often worked. As this action necessitates the pinion working on an axle having a universal joint, it follows that an inequality of motion would arise, were it not that a modification in the shape of the teeth of the pinion has been made which ingeniously neutralises the irregularity, and thus permits of this form of motion being used, which has some advantages on the score of simplicity and compactness.

The beautiful edition of the Bible published by Messrs. Mame et Fils has been printed by this machine.

M. Gaveaux (66) exhibits a printing-press for journals which is the only striking novelty in presses shown. The special object M. Gaveaux has in view is to reduce the size of his machine. The length of a press must depend on the size of the sheet to be printed, as the whole of the type must pass clear of the impression cylinder. With a view of reducing this dimension, M. Gaveaux has given a motion to the cylinders as well as to the table in opposite directions,

hence the travel of the latter is diminished by one-half. To judge from appearances, an amount of complication results from this arrangement, which would hardly be balanced by any question of gain of space or weight of machine alone, and I am not aware that it is anticipated that the system will present particular advantages in point of speed.

This press has not yet been practically tested, though it is in working order, having had blank sheets of paper passed through it; possibly it may be at work ere these pages are published.

Alouzet (67) shows further examples of what the industry of France can produce in the shape of well-made presses.

Messrs. Dutartre (69) are remarkable for the mechanical excellence of the presses shown and the care taken in their design. Messrs. Dutartre claim that their presses are made with sufficient accuracy to permit of the impression being passed more than once under the printing cylinder, a proceeding which renders an incomplete impression impossible. A double-colour machine is also shown, which is in principle the same as others previously described, the impression-cylinder being in the centre, and having on each side of it a type-table and inking-rollers for each colour, and which together, having at separate operations transferred their impression to the paper, complete the operation. For each impression two revolutions of the impression-cylinder are necessary, one corresponding to each colour.

The exhibitors from 72 to 81 show a variety of felts and inks, all of which are good, and some of them, no doubt, of a very high degree of excellence.

Dry ink printing press for cards, by Leboyer.

M. Leboyer (82) shows a novel arrangement for printing, which, under certain circumstances, presents advantages. The object effected is to print without ink, or rather with dry ink. The card to be printed is pressed on to the type dry, but having between it and the type a ribbon, which is imbued with the colouring matter—black, red, or green, as may be required—the nature of which is such that it only comes off under pressure. Hence it is transferred to the card at no other point except where it touches the types, which are set up in the usual manner. By successively using different-coloured ribbons ornamental business or invitation cards may be produced. The press is well made, and has a self-acting arrangement by which the cards, which are put into a hopper, are struck out one by one, passed under the stamp, and delivered complete. The advantage of the system appears to be that it simplifies the machinery of the press, as it does away with the inking apparatus, substituting a simple endless band, while, furthermore, the mess and dirt of wet ink is

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avoided. The machine costs 800f., and will print 5,000 cards per hour.

Flamm's typographic compositor, composing direct on the matrix.

M. Flamm (86) exhibits a typographic compositor, or matrix printing-machine, the intention of which is to obviate the necessity of setting up type for the stereotype process.

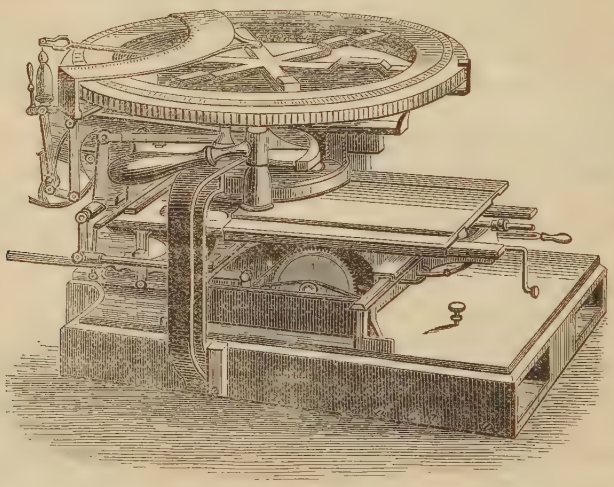

Fig. 1.—FLAMM'S TYPOGRAPHIC COMPOSITOR (CLASS 59).

As previously stated, in printing only a certain speed of cylinder can be used, hence the number of impressions is limited which can in a certain time be taken from one set of types; where more than this number are required, as in the case of a journal having a large circulation, they could only be obtained by using other cylinders, which would necessitate the provision of more types, involving also the tedious and expensive operation of setting them up. To avoid this the stereotype process is resorted to, which consists in using the original type as a model from which blocks of stereotype can be cast. An impression having been made in some soft matrix, the metal is poured in, and a facsimile of the original produced, which is printed from in the ordinary manner. Any number of stereotype blocks can be cast from one set of types when once they are set up. The object of M. Flamm is to do away with the preparation of the type by hand preparatory to the above process, and to impress the characters by machinery on the soft matrix, which becomes at once the mould in which the stereotype is cast.

In a large printing establishment it is necessary, at considerable expense, to provide a great quantity of type, which requires frequent renewal, as from use it wears out. To recast a fount of type is a somewhat costly operation; further-

more, after the type has been used it requires, before it can be again available, to be distributed—involving a farther expenditure of labour. It will be noticed that by the matrix compositor the types are only employed to produce impressions on the matrix; hence they are rather stamps than types, and can therefore have such care bestowed on their manufacture as to make them last a long time, working on to the soft matrix, with which only they are brought in contact. With the compositor, therefore, no founts of type are necessary; moreover, the labour of composing by the machine is less irksome than in the ordinary manner.

The cost of the machine is 1,500f., and six have been up to the present time made, all of which are stated by the inventor to have given satisfaction. It seems that there have hitherto been legal difficulties in the way of introducing this machine into France, as it would interfere with certain printers' privileges.

As regards the speed at which the machine can be worked, Mr. Flamm states that from 1,200 to 1,500 characters per hour may be printed, which is the most that an experienced compositor can effect.

With a slight exception, the effect obtained by this and Mr. Sweet's machine is the same; a description of the latter will be given when I come to the American section. The dates of the two patents are—Messrs. Flamm, June 1864; Mr. Sweet, November 1866.

The former gentleman's machine consists of a horizontal wheel, on the axis of which is a second one, this latter carrying a series of movable types, which on being struck down, leave their impression on the matrix beneath them. When the type-wheel has been put in the proper position it rests with the machine to cause the type to be depressed and replaced, and to advance the matrix the distance necessary for it to receive another impression.

The upper wheel is notched at its edge, each indent agreeing with a letter of the alphabet engraved alongside. This wheel is turned by hand until the required letter is opposite to a fixed point which ensures the corresponding type in the type-wheel below being over the requisite spot in the matrix. A movement is then given by a hand lever, which causes the following effects to be produced:—1st, it locks the upper wheel; 2nd, causes a hammer to descend on the proper type and make an impression; and, 3rd, causes the form carrying the matrix to advance a distance corresponding to a letter.

If the upper wheel be not adjusted exactly the locking action cannot take place; thus the attendant is warned that

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something is wrong. The form carrying the matrix is very similar to the slide-rest of a lathe, where the horizontal motion is in connection with the hand lever above described, and the movement at right angles, corresponding to the width apart of the lines, is given independently by hand.

The first of these motions is capable of variation at will, by means of a small lever, so that the printer using the same type can vary the distances apart of his letters, thus facilitating the justification of his lines. This is a movement which is wanting in the American machine.

To compose, therefore, three motions are necessary:—

1st, the adjustment of the big wheel; 2nd, a movement of the side lever affecting the printing and the advance of the matrix; 3rd, at the end of each line the revolution of a handle which causes the whole form to advance a distance equal to that which the lines are apart.

It is the first operation that, as the machine is now arranged, must consume some time which possibly might be avoided.

The apparatus may be used for lithographic as well as stereographic purposes.

M. Flamm has not divulged the way in which he prepares his matrix, but while soft and at the same time firm, it admits of being rapidly hardened by heat, so that the metal may be poured on it in some 20 minutes after it has left the machine.

Attached to the form is a table carrying a piece of paper, on which, at each action of the stamp, a pricker descends and makes a mark, the object of which is to enable the printer to have constantly before his eyes the position in which his work stands.

A commission, which was appointed, in 1866, by the French Government, to inquire into the merits of this invention, thus sum up and conclude their report:—"The "typographic compositor of Messrs. Flamm is likely to "render good service. 1st, to lithographers, for general "press-work; 2nd, to large administrative offices; 3rd, to "public companies; 4th, to armies during a campaign. "Nor does it withal menace the handicraft of the ordinary "typographic workmen."

With this latter opinion, though it may be correct as far the machine exhibited goes, I differ, as if the system is good, it is essentially of value in doing away with the skilled labour ordinarily required for setting up type.

Derriey's bank-note numbering machine.

Derriey (87) has a very good exhibition of presses for printing and numbering railway and other tickets, which are well designed and arranged; they embrace, however, only

well-known mechanical movements, and present no peculiarity of arrangement. M. Derriey exhibits besides them a machine for numbering bank-notes, which is worth very close attention. The object of the machine is simple enough; the difficulty consists in handling auomatically so thin and flimsy a thing as a bank-note; moreover, any mistake in the working of the machine might be productive of serious consequences.

The apparatus is fitted on to a flat metal table, and consists of two parts: first the stamping arrangement; and, second, the means for presenting the notes successively to its action.

The first part is simply a press, having no specialty, and consisting of the usual stamping and inking arrangemenst, the stamp itself being numerical, and similar to those described in a former part of this report.

The second part is as follows:—The notes are placed in a receiver, sunk below the level of the table, and at a certain distance therefrom is a second receiver, into which they have eventually to be transferred, between the two being the stamp.

A form slides from one hopper to the other, having cut in it a hole corresponding to but smaller than the bank-notes. Round the edge of this hole is a longitudinal slit, passing only half way through the metal, and in communication with an air-pump worked by the machine serving to keep a partial vacuum in the slit. On the hole in the form being brought over the hopper the vacuum attracts the uppermost note, which is thereby securely held. A blast of air playing for the moment against the edges of the notes in the hopper ensures only one being taken at a time. Having thus caught the note, the form moves under the stamp, when the impression is given, and a second motion takes the note to its destination, when, the vacuum being replaced by a puff of air, the note is released and falls into its place. It will be noticed that the notes in the two hoppers require to be always under a given pressure, and so placed that the position of the upper levels of the two bundles is the same. An ingenious self-acting arrangement effects this, and counteracts the irregularity that would otherwise arise as the notes are gradually withdrawn from one hopper stamped and transferred to the other. The price of the machine is 12,500f.; but though it is well made, and works, no doubt, very efficiently, the above sum would appear high; still, it should be borne in mind that the number of machines that can be required is small.

Mathieu (87 bis), Trouillet (88), exhibit small presses and stamps with mechanical numbering apparatus. Both makers

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effect nearly the same object by means of neatly-constructed and efficient little stamps resembling those which, in one shape or another, are now to be found in general use in large offices. The numerical stamp can be arranged so as to print consecutive numbers, to print always the same number, or to print the same number two or three times before passing on to the next. The prices of these apparatus vary from 20f. to 200f., the cheap ones not being self-inking. A very good serviceable stamp for general purposes may be had for about 70f.

Stuart's pulp reducer.

Montgolfier (108) shows an American machine, which is the invention of a Mr. Stuart, for further grinding up or reducing pulp for paper-making, of whatever material it may be composed. This machine is in a building in the park, nearly opposite to the Rue de Normandie of the main building. It has been employed in America, but has not as yet come into any very extended operations in Europe. The mill consists of a vertical revolving disc, which is faced or serrated with knives; this disc is placed between two others, which are stationary. The stuff to be ground enters at a central opening in one of the stationary discs and passes out by a similar hole in the opposite one. The knives are ordinary steel blades, much the same as those of a rag-engine, and set in a soft matrix, after the manner of the fastening shown by Meyer (21). The stuff to be ground is mixed with water in a reservoir above the mill, and thence allowed to flow between the stones. It would appear that the functions of this apparatus are very similar to those of an ordinary rag-engine, and the advantages of employing it would turn on the first cost of the apparatus and the power necessary to drive it. The machine did not often work, and it was somewhat difficult to get full information; a small portable engine, of apparently six-horse power, was attached for the purpose of setting it in motion.

Machine for copying medals, by Delos.

Delos.—This exhibitor is not in the catalogue of class 59; but, nevertheless, belongs to it, and has been judged by the same jury. The exhibit will be found not far from the exhibition of hatmaking. The machine is for copying medals or other objects of a similar nature on copper in such wise that the copper-plate may be printed from, and the principle on which it works is, so far as I know, original. A dumb tracer passes over the medal to be copied, and a cutting point of diamond is put in such relationship with it that the vertical elevations af the original give equivalent horizontal motions to the diamond, a sort of shading effect is thereby produced which forms the copy. Were a plain surface only to be copied the result would be a series of simple parallel

lines; any raising of the surface producing a figure would result in corresponding bends in the lines (still on the same horizontal plane) of the copy. There is an arrangement by which the scale of the copy can be altered, and the manipulation is evidently irrespective of skilled labour. The samples of work done that were shown me were not artistic, but they were curious; and, moreover, I was informed that they should not be considered as fair evidence of what the machine was capable of doing.

This completes my notice of the French section of class 59. It will, I think, be generally allowed that, while no striking novelty has been brought out, the display is a very good one, and proves that, so far as regards printing and paper machinery, the French are keeping up to the times. They have displayed great ingenuity in the arrangement of some of their smaller machines, as for instance, MM. Poirier's machine for folding envelopes, the stamps of Messrs. Mathieu and Messrs. Trouillet, or the machine by Messrs. Fredureau and Chavannes for folding and cutting the leaves of books.

## Belgium.

Belgium.

Passing over Algeria and the Pays-Bas, who exhibit nothing in class 59, Belgium is the next country that is reached. There are eleven exhibitors in the catalogue, of which two have failed to appear. The Belgian machinery, generally, has been considered as on a par with that of France, and the two together offer the best examples of what the workshops of the Continent can turn out. The price of labour in Belgium is low, which makes her a very formidable industrial opponent; at the same time that very lowness in the value of handicraft is of itself a bar to the progress of manufactures in the country, as it stands in the way of the introduction of machinery, and, consequently, of improvement. The Belgian exhibition, in class 59, is not so large as might have been expected, more especially as some of the Belgian makers have a good name for their paper-machines. However, the only complete paper-machine shown in the whole Exhibition is a Belgian exhibit.

Continuous paper machine by Dautrebands and Thiry.

Dautrebande and Thiry (1).—This machine is well constructed, but presents no very striking peculiarities; the pulp is received on an ascending and descending strainer—that is, the perforated metal plate or sieve used for separating all knots and impurities from the pulp is made in two halves with a division separating them, and the holes in each are cut the reverse way to one another, so that the pulp must pass twice through the strainer before being delivered to the machine. The shaking motion is given by means of a cam

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at one end of the strainer, which arrangement causes the amount of movement to diminish from a maximum above the cam to *nil* at the point where the pulp is delivered on to the wires.

The top couche roll is furnished with a brush doctor in place of a piece of felt, which is the ordinary arrangement. The brush has given to it a reciprocating motion to ensure its efficient action. The steam for the drying-cylinders is brought by pipes both in and out of the same end, an arrangement which would hardly appear so good as to take it out at the opposite end of the cylinder to that at which it was introduced. The whole of the driving gear is situated at one side of the machine, leaving the other free for the circulation of the attendants.

The felts which accompany the roll of paper in its passage round the drying-cylinders are kept in their proper positions by self-acting gear, the mode of action of which will be readily understood. It consists of making one end of the rolls carrying the felt and paper moveable, its bearing being connected with a screw; attached to the end of the roll is an eccentric pin which gives a vertical motion to a couple of pawls working into a double-faced ratchet, and according as one or the other side of the ratchet is in gear so the screw is moved backwards or forwards; the pawls are, by means of a lever, acted on directly by the edges of the felt.

This arrangement is not new, nor is it in all cases considered necessary, as a certain amount of superintendence cannot be dispensed with, and such attention as is necessary to keep the felts running properly is within what the attendant can well give. Under certain circumstances, it is questionable whether a point may not be reached beyond which it is undesirable to make a machine entirely automatic, as by so doing the attendant is relieved from all necessity of attention, though nothing in point of economy is gained thereby, since his presence cannot be dispensed with. For the above reason I am inclined to think that all automatic arrangements for feeding steam boilers are in principle wrong, since it is impossible to make them in such wise that it is absolutely certain that they should never fail to act.

After the paper has left the drying-cylinders, it is received between rollers, whence it passes to the cutting engine, which cuts it in two ways, horizontally and transversely. There is a single stop-cock which shuts off the steam from all the drying-cylinders, and each of the pressing-rolls is furnished with a conical friction-clutch, so that it can be at once thrown out of gear.

The price of the machine, as it stands in the Exhibition, is

55,000f.; but, as certain parts have been got up for show, a machine in every way as good for work can be made for 51,750f., packed ready for delivery in the maker's yard. The exhibited machine cannot, however, be said to be complete, as it would need several accessories before it could be set to work.

Type-composing and distributing machines, by Delcambre.

Delcambre (2).—There is no work which it is more desirable to reduce in cost than that connected with printing, since it is the universal and almost the sole agent for propagating knowledge; hence all reasonable proposals for reducing the labour in connection with typography deserve especial study. That branch of work in a printing establishment connected with the manipulation of the type is of a peculiarly distressing and wearisome nature, necessitating constant attention both of the mind and body. The machines exhibited by M. Delcambre have been designed with a view to lessening the work of composition and redistribution of the type after it has served its purpose in the printing press.

The first machine is for composing. The ordinary method is for a workman to have before him a box containing in different compartments all the type he requires; thence he selects and arranges them by hand into words and sentences. It is this selection and setting up which M. Delcambre proposes to effect by his machine. The letters and various symbols used in printing are contained in reservoirs consisting of long slits, which are closed at the bottom by a sort of valve or lever, which on being actuated permits of one, and only one type to fall out. The valves are each in relation with the keys of a keyboard similar to that of a piano, each note of which would correspond with a letter. Thus, on pressing down any one key, the action would permit a corresponding type to fall out of its reservoir. The connection between the keys and the valves is by means of a very simple system of levers, which, in the event of anything going wrong, can be readily readjusted, since they are open to view. Under these circumstances the compositor has only to read the sentence he wishes to compose, and, touching the keys, the letters and blanks he requires will fall out of their reservoir in the order in which the keys are struck. It remains to arrange for their being formed in the composing-box. To this end the types are received on a series of inclined planes, all ending in one channel; and the lengths of these planes are so arranged by suitable curves that the time necessary for a type to traverse each one is the same; hence the letters arrive in the single channel in the order which the keys are struck.

At the end of the channel each type falls over and takes its place in the sentence. To ensure its doing this, a small

lever keeps up a constant light vibrating motion acting on the head of the type, and rendering it impossible that it should stick fast. This lever is driven by a simple movement from a wheel which is kept in motion by the foot of the workman.

Fig. 2.—DELCAMBRE'S TYPE-COMPOSING MACHINE (CLASS 59).

The type is thus composed into one long string of words, which is afterwards broken up into lines by the ordinary means.

One would be apt to think that accidental circumstances, readily occurring, would interfere with the even flow of the type in their respective channels, and produce confusion; but it is remarkable how regularly the machine did its work, and it is obvious that any mistake made can be rectified as readily as if the type had been set up by hand.

The distributing-machine acts in a manner the reverse of the compositor, its object being to take the type when the sentences require to be broken up and distribute the letters

into their respective reservoirs ready to be re-used by the compositor.

The machine consists of a single hopper or reservoir in which the sentences to be broken up are placed, the bottom of which is closed in a way similar to that employed in the machine before described. The types, in falling, are received in a channel down which they slide, until arrested by points something similar to railway points, which shunt them into the channels leading to the different reservoirs; these points are in connection with, and worked by, the keys of a key-board, similar to that of the compositor.

The compositor with his right hand presses down the keys one by one, and thus turns the points corresponding to the reservoir into which he wishes the type to pass. With his left he works a lever which permits a type to fall from the

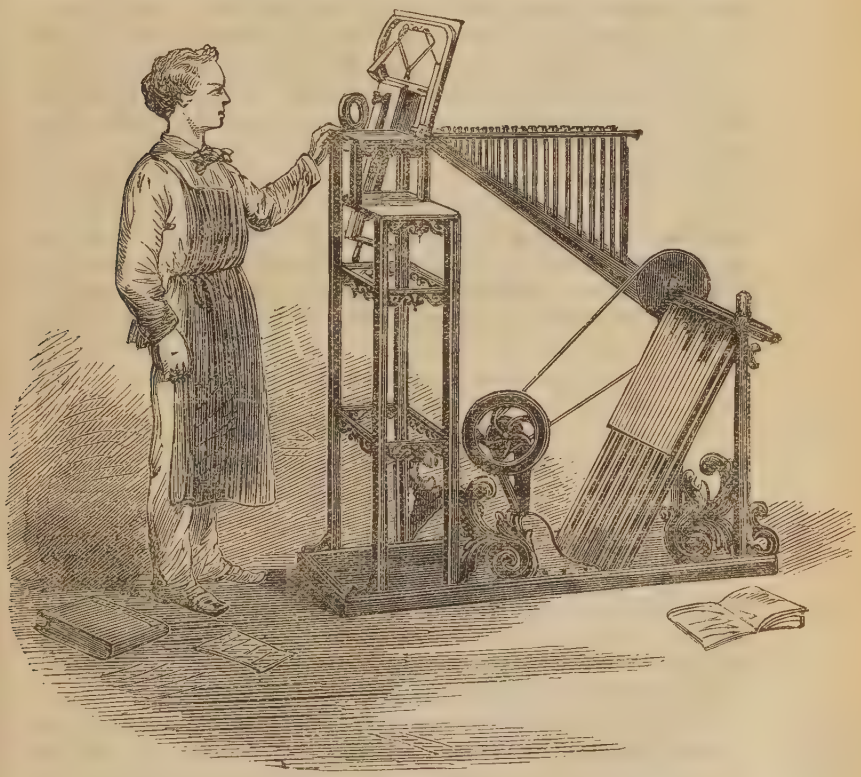

Fig. 3.—DELCAMBRE'S TYPE-DISTRIBUTING MACHINE (CLASS 59).

general hopper. It would be easy to put this latter motion in connexion with the first, and so make one movement effect the two objects. As all types are not the same thickness, it

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will be noticed that an ingenious provision has been made against the difficulty that this difference of size would involve in their delivery from the reservoir.

The price of the composing-machine is 1,500f.; that of the distributor, 600f. The inventor states that, by the use of these machines, one person can do the work of four; and their manipulation is so simple that a person of ordinary intelligence can obtain full proficiency in a very short time. Indeed, this would appear probable, as the work is confined to reading, and touching the keys accordingly.

Machines similar in principle to the above have been shown at previous Exhibitions, though not quite in the form which they have now assumed.

It is only, of course, by full and long trial that the value of these machines can be ascertained in an economical point of view. An inspection of them in the Exhibition will show that they are worked out in a practical manner, and do the work up to a certain speed expected of them. I should like to see whether the machines would work properly up to the highest rate at which an expert operator could strike the keys.

Gouweloos (4) shows a machine for perforating postage-stamps, which consists of a series of small punches, corresponding to the holes to be made, to which a vertical motion is given. The sheet of stamps has also a progressive motion, and the two movements are so timed that the punches strike the paper at intervals corresponding to the length of a stamp. No doubt the machine would do a large amount of work; but the arrangements of mechanical parts to produce the result aimed at presents no difficulty.

Washer (11) exhibits a paper-cutting machine for general purposes, which is well constructed and arranged in a mechanical manner.

## Prussia.

Prussia brings forward sixteen exhibitors in class 59, but they show little machinery; indeed, the greater part of the exhibits consist of samples of production, including several exhibits of cakes and wood and straw ready to be manufactured into pulp for paper-making.

Printing-presses for ordinary purposes and for colour printing, by Klein and Hammel.

Klein (1) shows some exceedingly well-made presses for general printing purposes. The movement which M. Klein has selected for giving a reciprocating motion to his printing-table consists of two wheels, one half the diameter of, and working within, the other, the table being attached to a point in the lesser wheel, which, under the above circumstances, describes a mathematically straight line. This method (which,

of course, is very old) for converting a circular into a rectilinear motion would appear to be very well adapted to the requirements of a printing-press. M. Klein uses in connection with his printing-cylinder an apparatus for ruling lines similar to that of M. Tournier, which has been described in my notice of the French section.

Hammel, whose name does not appear in the catalogue, shows some very well-made machines, an ordinary printing-press, and also a machine for printing a continuous roll of paper in six colours; the paper is passed round a single large cylinder, about which are grouped the separate printing or impression cylinders, corresponding to the number of colours which are required; each cylinder is furnished with its separate inking apparatus, and completes that portion of the pattern belonging to its colour.

Close to this machine there is another, similar in principle, for printing in one colour only, attached to which is an arrangement of brushes which have a combined horizontal and rotatory motion, for scouring the paper after it has left the impression-cylinder, and so removing any irregularity in the colouring. The principle of these presses is the same as that ordinarily employed for printing in several colours, and of which there are several examples in the Exhibition, amongst others the press of M. Ducommun, in the French section (31).

The Grand Duchies of Hesse and Baden have each one exhibitor in class 59, but they show nothing worthy of special notice.

## Wirtemberg.

In Wirtemberg, though the kingdom boasts of only two exhibitors, it includes the most interesting exhibit made in class (59), and which should be closely looked into by all those interested in the manufacture of paper.

Apparatus for preparing wood pulp, by Voelter and Decker.

Voelter and Decker (1) show a complete apparatus, made according to the most recent patents of Messrs. Voelter and Decker, for making pulp from wood. The machinery is in a building by itself in the park, not very far from the grand avenue by which the Exhibition building is approached from the side of the Ecole Polytechnique. It will be found without difficulty, as the exhibition is a popular one.

Messrs. Voelter and Decker have been for twenty years experimenting on the use of wood for making paper, and have succeeded in introducing it on the Continent; but in England, for some reason or another, the system has not found much favour. In their advertisement circular, it will be seen that

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ninety machines have been supplied, of which two, one each, have gone respectively to England and America.

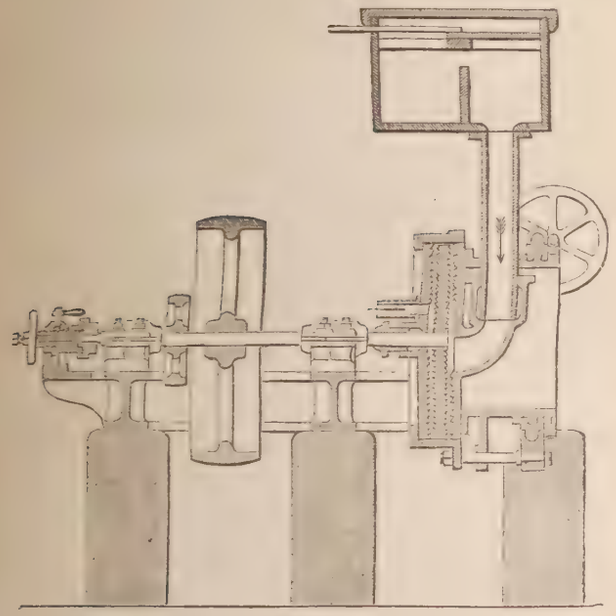
Of course, the only object in substituting wood or grass for rags as a material for making pulp is economy; and possibly the relative prices of rags on the Continent and in England, together with facilities in the former locality for producing wood pulp, may be such as to account for the fact of little use having been made of the process in England. The value of rags will be affected by the duties to which in some countries they are subject, and the price of labour and power in those situations where paper manufactories are generally established may be higher in England than abroad.

The following statistical information in connection with Messrs. Voelter and Decker's process is taken from their circular. Wood pulp manufactured according to their process may be mixed with rag pulp in proportions varying from 18 to 80 per cent. according to the quality of the paper—viz, 15 to 50 per cent. for good writing and printing paper; 50 to 70 per cent. for ordinary writing, printing, and wrapping paper; 50 to 80 per cent for common paperhangings and cardboards. Pasteboards may be made entirely of wood pulp. The advertising circular above referred to, in the shape of a pamphlet, is printed on paper containing different proportions of wood pulp, hence the nature of effect produced may be very closely examined by noticing the texture of the different leaves.

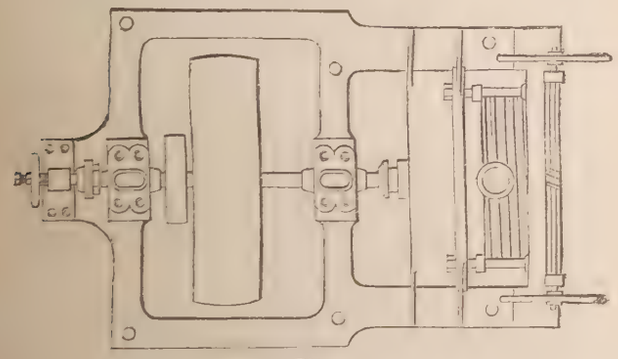
Pine and fir wood give the best fibre, while ash and lime produce the whitest pulp; all woods of similar character may, however, be used; and indeed, any wood will produce pulp. Birch and beech have been used extensively both in Belgium and France.

It is very desirable that the water used in the process be clear; if dirty river water be used it must be filtered, or the pulp will be coloured. Hard water containing lime is not only not unfit but very suitable for the purpose. An expenditure of 5-horse power effective is required for twenty-four hours to produce 1 cwt. of wood pulp air dry. Therefore, a 40-horse power mill, working day and night, will produce 8 cwt. of pulp. An excess of power, even on that liberal allowance is, however, recommended. For the production of 1 cwt. of pulp 2 cwt. of wood is required. Young wood from 3 in. to 12 in. in thickness, is preferred, and it should not be kept in store more than six months before being used. The wood must be cut into pieces about 12 in. long, and all the knots, bark, and other impurities removed. Waste pieces of wood, provided they are not too small, may even be utilised.

For every hundredweight of pulp made, a water supply



Section.



Plan.

Fig. 4.—STUART'S PULP ENGINE (CLASS 59.)

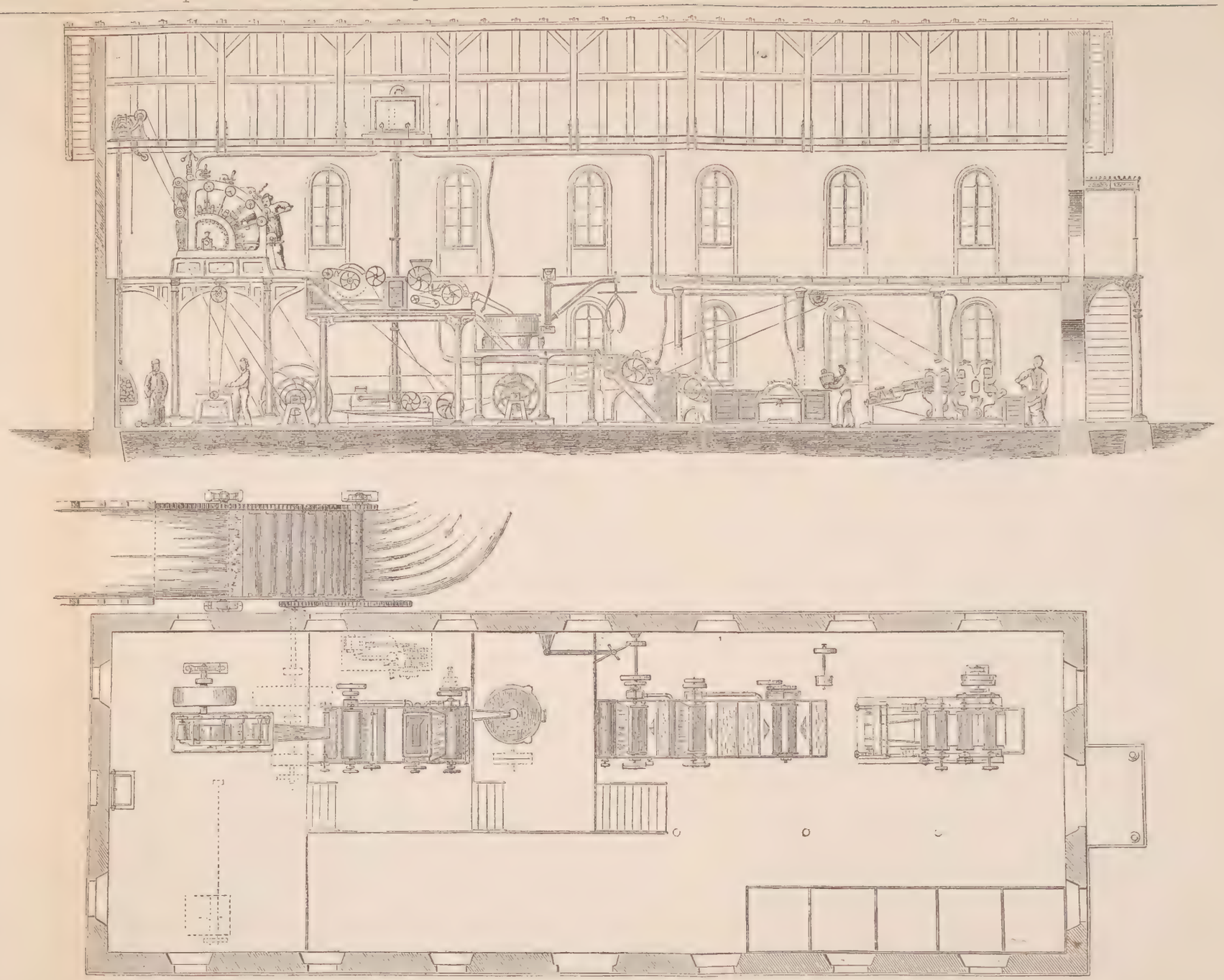


Fig. 5.—WOOD-PULP MANUFACTORY, WITH H. VOELTER'S PATENT MACHINE (CLASS 59).

throughout the twenty-four hours has to be kept up of from one-half to three-quarters of a cubic foot per minute.

Besides the foreman, each hundredweight of pulp made in the twenty-four hours requires one man. From the price-list, a 60-horse power machine will weigh nearly 9 tons, and cost 515*l*, irrespective of packing, delivered in the manufacturer's yard. It is likely that, besides the above sum, a heavy bill for extras would have to be paid, irrespective of driving-power.

From the above details it will be seen that, with a 60-horse power machine, working day and night, 12 cwt. of air-dry pulp would be produced, at the cost of the wages of 12 people, irrespective of foremen, engine-drivers, and stokers, if steam be used, to which must be added the price of power and wood, depending on the locality; and, farther, the charge of transporting the pulp to the paper-machine, unless the pulp and paper mills happen to be close together.

Now, if all the above charges are fairly assessed and added to interest of capital, and the wear and tear of machinery, a figure will be arrived at which will throw some light on the question why the system has found so little favour in England, where labour and wood are high priced, and where water-power is not so common as on the Continent.

Messrs. Voelter state that they have tried to use wood pulp for the manufacture of picture-frames, statuettes, and the like, as a substitute for papier-mâché, and that fairly satisfactory results have been obtained. I believe there is a chemical means of reducing wood to the form of pulp, but I have not heard that as yet it has been practically successful. Messrs. Voelter state that the fibre of the wood, on which its value depends, is destroyed by the process, while, by mechanically reducing it, the fibre remains uninjured. The machine by which the above operation is effected may be described as a big, vertical grindstone, against which the wood to be ground is pressed, while a stream of water assists the operation and at the same time keeps the working parts cool. The wood thus ground down is passed through successive sieves until the residue is of the required degree of fineness.

At the Exhibition the mill is driven by three of Messrs. Colla's portable engines, of about 15 or 17 horse power each, two of which are kept running together. It would, however, require the power of all three to work the mill up to its full productive power. The grindstone is of the ordinary description, with a hammer-picked face, the one in the Exhibition being about 4 ft. in diameter, and making from 150 to 180 turns per minute. Around its periphery are

fixed five boxes, or hoppers, which receive the wood to be ground, and which has been previously cut up into proper lengths by a circular saw. These boxes are fitted with sliding covers, which are gradually forced forward by screws as the stone wears the wood. The amount of feed (which is necessarily very small) is regulated by a governor similar in principle to those which are used in connection with water-wheels. It is driven from the main shaft, and causes an increased or diminished feed to be given, according to the velocity of the stone, and, consequently, the pressure of the wood against it. A simple arrangement permits of the slow motion of the feed-screw being dispensed with, and the cover rapidly withdrawn by means of a rack and pinion, when it is required to renew the charge of wood.

This first process reduces the wood to a mass of pulp and splinters of different degrees of fineness. To separate the larger from the less, the whole, profusely mixed with water, is passed into a trough containing a revolving cylindrical strainer, permitting only of stuff of a certain degree of fineness passing through it. All those pieces which from their coarseness adhere to the outside of the cylinder are thrown away as useless. The pulp then undergoes a similar process again, but the strainer is much finer, and the pieces of wood which it separates are worth being farther dealt with. As they are separated by the action of the revolving strainer they are carried with a stream of water to the centre of the upper of a pair of ordinary horizontal millstones, where they are reduced by grinding to the same condition or quality of fibre as that coming direct from the grindstone. It remains now only to separate the pulp into three degrees of fineness, according to the purpose for which it is intended. This is done by passing it through strainers of various degrees of coarseness, that which separates the very finest pulp having a mesh with 40,000 holes to the square inch. The pulp is then dried partially by the action of the air, and partially by being pressed between rollers, when it is ready for use. If, however, it has to be transported, as a matter of economy the drying process must be completed.

In Germany wood pulp sells for about 36f. per 100 kilos (or nearly 15*s*. per cwt.) In France it is worth 50f. per 100 kilos (or nearly 1*l*. per cwt.). The condition of the matter is air dry—that is, containing some 10 per cent. by weight of water. In Germany rag pulp costs double wood pulp, or 72f. per 100 kilos.

The above figures were given me by Messrs. Voelter and Decker; but I confess I cannot see how such prices can pay

for the expenses I have detailed above, unless power and wood be got for nothing.

In England the Spanish or Espartero grass is much used as a substitute for rags. It appears to have the necessary length of fibre, and can be imported at a price which enables it to be economically used. The supply in those countries where this grass grows is practically inexhaustible, though its cost is much influenced by the locality from which it is procured, as in the countries where it is found means of transport are usually very defective.

## Bavaria.

Kœnig and Bauer (2) are noticeable for the high class of workmanship shown in their presses, which leaves little to be desired in accuracy of fitting or a skilful arrangement of parts. Messrs. Kœnig and Bauer send a considerable number of their presses to Russia and Germany.

Kœnig and Bauer, presses for ordinary and colour printing.

Two printing-presses for general purposes are shown, one of which in design presents no novelty ; the other has the same reciprocating motion for the type-table which has been described in connection with the press of Messrs. Klein in the Prussian section. The inking arrangements are somewhat modified from those generally employed. The ink is taken from the fountain and spread on the type by means of distributing rollers, but the usual inking-plate is substituted by a roller.

There is also a two-colour printing-machine shown, which is the same in principle as those previously described, the impression being completed by two distinct operations, and separate type and inking apparatus is arranged at each side of the impression-cylinder, which latter makes a complete turn and return for each complete operation of printing. The double-colour machine will throw off 1,000 copies per hour, and costs, at Messrs. Kœnig and Bauer's works, near Wurtzburg, 9,000f. (360*l.*); the other press, for journals, costs 7,000f. (280*l.*), and is stated to work up to 1,800 impressions per hour.

## Austria

shows next to no machinery in class 59, her exhibits being confined principally to accessories belonging to different branches of the paper and printing trades. M. Weiss (12), however, is the sole exhibitor of rags in the Exhibition; he has contributed some samples of compressed rags. The duty of 2 fl. per Zoll. cwt. makes it possible to export only the highest quality of material, and, owing to the competition

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with Russia, Italy, and the Levant, the exportation from Austria is not large.

### Spain and other Countries.

Spain has, according to the catalogue, five exhibitors, which an even diligent search failed to discover.

Italy has in like manner six, of which two only were to be found.

Turkey has one by name, Cheik Ali Mehmed, which I looked for, as I was anxious to see what contribution to printing a Syrian village could produce. I did not, however, get more than a verbal description of M. Mehmed's stamps, and the official who gave it to me seemed to think I had missed little in not seeing the originals.

There is nothing further shown in class 59 worth noticing till we come to the

### United States,

who have nominally eight exhibitors, of whom several are absent.

Sweet's matrix compositor.

Sweet (3).—This machine represents the most promising invention in connection with printing which is shown in the Exhibition, and if the mechanical difficulties still remaining can be overcome, and the machines stand a practical test in the printer's hands, I see no reason why a revolution in printing should not be made, since the use of this system is more rapid than the ordinary one, and it dispenses with the cumbersome and costly founts of type hitherto necessary. The object to be obtained is the same as that aimed at by M. Flamm (86) in the French section; but the means by which it is effected is different.

It will be well first to get clearly an idea of the principle of this extremely ingenious machine, which is as follows:—The platen attached to the matrix is carried under a wheel containing the type, the depression of any one of which stamps the matrix; this wheel is kept continually revolving, but can be stopped in any position by raising certain pins in a corresponding wheel below, which pins are in relation with the keyboard of a sort of piano, whose notes would correspond with the different letters; hence the depression of a note raises the corresponding pin and stops the type wheel in such a position that the proper type is over the matrix, when the depression of the stamp forms the impression.

Having, I hope, got an idea of the principle, the reader will now readily follow a more detailed description:—

The machine in appearance is like a harmonium with two rows of keys and four separate ones, above which latter are

the spaces. Of course any number of keys may be used, corresponding to the number of types required. Above the keyboard is a fluted or grooved roller, which, on being turned, moves forward the form carrying the platen and matrix. There is on the left side of the machine an arc, on which is shown the amount which the roller has turned, and, consequently, the position of the platen. Behind the machine is a circular disc, near the periphery of which are inserted a number of pins, one corresponding to each key, and which, in their normal position, are flush with the top of the plate, but are raised by the depression of different keys. Above this disc is an axle springing from its centre, which carries, first, the real type-wheel; and, second, the apparatus for causing the type in it to make an impression. Beneath the type-wheel, and on the same axis, is an arm which sweeps round just above the lower disc, and which, when no pins are raised, runs continuously round, being driven by a band from a small pulley, which may be turned by the foot, or in any other convenient manner. Attached also to the arm is a lever, whose duty it is to push the pins back in their places after they have done their work of stopping the arm. After the rotation of the arm is arrested, the pulley on the axle continues to travel on, and the result of its motion is the depression of the hammer by which the types are forced on to the matrix. This is effected as follows:—The pulley which drives the axle is partially loose on it, and carries a piece of metal which is in front of an inclined plane, which latter is made one with the type-wheel; the piece of metal is in connexion with the lever working the hammer by which the type is depressed. When both the piece of metal and the wheel are running together no effect is produced on the hammer; but when the latter is arrested, the former mounts the inclined plane and puts the hammer in action. Attached to the hammer is a small catch, which, after the type has been replaced, brings it back to its original position.

In connexion with each note of the keyboard is a pawl which takes into the teeth of the roller described above; and the act of raising the key, which is performed by the arm of the type-wheel, causes this pawl to turn the roller round, and so advance the form containing the platen, with which it is in connection.

The divisions of the teeth of the roller, and its connexion with the form, are such that one tooth corresponds to an advance of 1-64th of an inch of the form. The pawls attached to the keys are arranged so that they are depressed more or less according to the width of the letter to be printed—thus, for a w, six teeth; while for an i, only three are taken. An

arc is attached to the lever at the side of the roller, which serves to show the exact position in the line which the types are printing.

On the conclusion of a line this lever is replaced by hand to its original position, corresponding to the commencement of a fresh one; it is necessary also that a lateral movement of advancement be given to the platen, so that a fresh portion be presented to the action of the type after each line is completed; and this is effected at the same time that the whole form is moved by the side lever. The bottom of the platen is scored with inclined groves, which are taken into by a small stud fixed in the frame of the machine, and which are so arranged that the said stud takes a fresh groove each time the whole form is retired, the distances apart of the grooves correspond to the widths apart of the lines of the printing. I hope, on considering the above explanation, the action of the machine will be readily apparent. The compositor, sitting in front of the machine, keeps the type-wheel in motion with his foot, at the same time that, reading the manuscript, he successively puts down the keys corresponding to the letters, when the following actions result:—The type-wheel is arrested in such a position that the type corresponding to the key struck is over the matrix; the pulley, continuing its motion, causes the piece of iron above described to mount the inclined plane and depress the type, stamping the matrix, after which the pin raised is depressed, allowing the arm to continue its motion, and at the same time replacing the key, and thereby turning the fluted cylinder, and so advancing the form a distance corresponding to the width of the letter.

In correcting, the matrix is passed again under the type-wheel and the correction made. When the stereotype is cast, of course, a double word is the result, but the superfluities may be readily cut away; and, though the inventor does not pretend that a perfect substitutton is the result, yet the alteration is always quite legible. In some cases, where the letters happen to be similar, the correction would hardly be noticed. The machine exhibited is the first that has been made, hence it is reasonable to suppose that subsequeut attempts will give much better results. With this one forty-five characters per minute have been actually printed, the limit of speed of the machine being sixty, though this rate in practice has never been reached, owing to want of skilled manipulation. The limiting rate of sixty characters per minute cannot with this machine be passed, as the parts would not then have time to perform their functions properly. The inventor hopes, however, with another machine to eventually

double that speed, or to reach the speed at which it is possible for the hand to depress the keys. The price of the machine is such that when any large amount of printing has to be done, its cost, more or less, becomes no serious consideration.

The machine exhibited is not adapted for newspapers; but it is obvious that with a little modification it can be adapted readily to all kinds of printing. It would appear likely that the principle of this system—namely, doing away with movable type and stamping the matrix at once—is one which, at any rate, in some way or another, will succeed; and, since it renders unnecessary the costly founts of type necessary by the old system, will reduce the cost of printing.

Printing-presses for light work, by Degener and Weiler.

Degener and Weiler (4) exhibit presses which are specially adapted for printing on a small scale and for hand-presses. The easy motion which they have, and the simple arrangement, are well worth notice. I believe this adaptation of parts is original. The press consists of two parts, which are connected by a hinge, one part carries the platen, and the other the type, to which is attached the inking-table. These two parts are doubled together like a book at each action of the press; but as the points about which they move are situated some distance below them, it results that a gradual and easy motion is given; and as the platen and the type approach each other, their speed is arrested with a corresponding increase of power. The centre about which the platen-table turns is fixed; but the centre of the type-table has a reciprocating motion given to it by a connecting rod from a toothed wheel turning on the said centre. When the impression is being taken and the press is closed, both parts are vertically together.

The course described by the type-table is sufficient to bring the type and the inking-table successively under the the inking-rollers, the axle of which latter slides in a groove, so that it can accommodate itself to the requirements of the former.

In the smaller size of machine the ink is supplied to the table by hand; but in the larger ones a regular ink-ductor is provided, which at each revolution of the machine comes into connexion with the inking-table, an automatic arrangement causing this latter gradually to turn round, so as to ensure an equable distribution of the ink. To the smaller sizes, especially adapted for printing cards and circulars, a sort of self-acting clip is attached to the platen, which delivers the cards, after they are printed, into a tray beneath the machine. Under these circumstances, 2,500 impressions may be made per hour. The price of the lesser

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press shown is 34*l.*, and that of the larger one, with ink-fountain, 80*l.*

Welsh (7) shows a clever little machine for dressing type, which it does by planing, in place of the ordinary method of grinding. The types having been set up, are made to pass between cutters, which at once reduces their sides to a true surface.

Mr. Welsh also exhibits a compositor's type-case, which is divided in a way different from that ordinarily in use, and the inventor states that the system facilitates considerably the labour of the compositor.

Though eight exhibitors are down in the catalogue, only the above three are to be found in the American section of class 59.

## Great Britain.

Bryan, Donkin, & Co.'s exhibit of parts of paper making apparatus.

Messrs. Bryan, Donkin, & Co. (4) exhibit apparatus in connexion with the manufacture of paper by machinery. There is nothing shown which is very new, but the machines are extremely well made, and no pains are spared by this firm to turn out their machinery perfect, not only in workmanship, but in design and arrangement of the smallest details.

A rag-cutter is shown. The rags are fed into the machine by an endless band, which delivers them to a knife having a reciprocating motion given to it by a crank on the flywheel shaft. The knife consists of a single blade, with three others at right angles working on a block of iron, and cutting the rags into small squares. A strainer is also shown in which the motion for shaking has been very nicely worked out, the result being that the whole strainer has an equable shaking motion instead of, as is usually the case, receiving a vertical motion by means of a cam at one end of the strainer, the other being fixed, whence the motion has died out before the pulp passes over the lip of the strainer to the paper-machine.

A cylinder, cut after the fashion of a strainer, is also shown, which has been made out of a single sheet of copper, in a very simple and ingenious manner: the plate being taken of a suitable size and thickness, is bent to a circle, and, having been put in a lathe, is scored with parallel lines half through its thickness; it is then taken out and bent at right angles to its former direction, and, being again put in the lathe, is similarly scored; the result being that, where the lines intersect each other, the metal is completely cut through, and an even series of holes produced.

Morel's system of electrotype.

Morel (6) shows samples of electrotype as applied to obtaining facsimiles of both type work and engravings; the

letters are clearly formed and will give, no doubt, a good impression. I have not been able to glean information sufficient to have a very satisfactory notion of the merits of the process, so shall quote Mr. Morel's own words on the subject. He says: "I have arrived, by successive improvements, at such a state of perfection that I am able to furnish facsimiles of forms of type as quickly and nearly as cheaply as by the common stereotype process, thus rendering electrotypes available for the ordinary purposes of printing where stereotypes are used. The durability of electrotype is so great that more than a million copies can be taken from one plate, so that books, and especially illustrated works, can now be produced more rapidly and much more cheaply than formerly. The process consists first in moulding the form in beeswax, instead of gutta-percha. The beeswax is then inserted in a metal frame, and the system of rendering it conductible is such that in a few hours a shell of copper is obtained sufficiently thick to be finished; this shell of copper is then thickened by a process so rapid that a sheet of sixteen pages can be obtained in a few hours. The *Art-Journal*, with its supplement, the *Bow Bells*, and several periodicals are printed from my electrotypes."

The above description does not state the way in which the beeswax is made conductible, nor the manner which is adopted for finishing the electrotype by fastening on a backing of another metal, and so rendering it fit for the printer's hands.

The Patent Printing Surface Company (7) show two machines, which have for their object to print on irregular surfaces, such as the curved face of a powder canister.

The press is described as a pneumatic machine for printing from vulcanised india-rubber printing blocks.

A cushion of air is introduced under the block, thus raising up its surface; and, being elastic, it permits of the printing surface adapting itself to an irregular shape. The air is introduced by means of a small pump, worked by hand. The machines were not at work, nor was there any attendant from whom I could obtain specific information; hence I cannot say what results may, in practice, have been obtained.

Steam calender, Robinson.

Mr. Robinson (9) shows a complete machine for glazing, by direct pressure, calico, silk, satin, or cotton goods. It will also glaze paper; but the rolls attached to the machine shown are not adapted for that particular purpose.

The machine consists of four cylinders, placed one above the other, with their axles in a vertical line, and supported by two strong standards. The rolls are of hard metal, every alternate one being covered with paper, and the higher of the

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two uncovered ones is provided with means by which steam can be introduced to heat it. The upper rolls are approached or withdrawn from each other by means of screw tackle, which is worked by hand from above, the lower roll being acted on by means of a right and left handed screw, which serves to draw up or let down a lever, which supports the bearings of the roll. Attached to the main driving-wheel is a pulley, which carries a strap, driving a roller on which the goods are wound after having been glazed. The machine is driven by a pair of diagonal high-pressure engines, each of 6-horse power nominal. They are fitted with the ordinary eccentrics and slide valves, and their connecting rods at right angles to each other catch hold of a single crank. The framework of the engines appeared to be decidedly light.

The price of the machine is as follows:—Machine 310*l.*; engine, 120*l.*; driving-wheels, 22*l.*; or together 452*l.* The two latter items may be dispensed with when other power is available.

Messrs. Stones (10) show a collection, which is second to none in the Exhibition, of wove wire, in the many ways in which it is employed by papermakers, maltsters, millers, confectioners, &c.

The dandy rolls and moulds for producing watermarks in paper are especially well turned out.

## English Colonies.

Canada is the only one of our colonies that contributes to class 59. The catalogue states that she sends four exhibitors, but only two are present.

Boissonault (1) shows a type-box where metal wedges are used for securing the type.

Julien (2) exhibits an ingenious press for printing addresses. The machine is designed for use in connection with a newspaper office where a great number of the same addresses are daily required. The apparatus consists of a long type-box, in which are placed side by side the addresses; this box receives a step-by-step motion onwards as each address is printed; the impression is made by a stamp to which a vertical motion is given by means of a single connecting rod and crank driven from a pulley at the side of the machine. The idea of the machine is good, but the way in which it has been carried out, and the workmanship, would hardly satisfy an English mechanic.

I have no doubt, however, that it can do good work, and possibly its price may be very low.

I have now been tolerably closely through class 59, and, though there is much required to make the review a perfect

Concluding remarks.

one, notice has been drawn to everything at all worthy of study.

I think the reader will agree with what I stated at the commencement of this report, that the Exhibition of 1867 has failed to produce any very striking novelty in connexion either with the trade of paper making or with the manufacture of presses; at the same time there is evidence that invention is not quite dormant in connexion with these trades.

The French exhibit is by far the most complete, and, indeed, may be said to be the only one in the Exhibition which at all represents the whole class. The sole notable want being a complete paper-making machine, of which France has got no example. With few exceptions, all the machines she shows are really well made, and creditable specimens of both workmanship and design, the fault principally being a too exuberant growth of invention, often making change for no good end, and an evident dislike to simplicity, or perhaps it would be truer to say a want of admiration for it. In many of their best machines there is full recognition of the standard English pattern, and no attempt has been made to improve the copy.

I should say that what *par excellence* the French excel in is their ingenious application of mechanics to small ends; matters in which it may be we could do as well, did we not rather (but hardly wisely) consider them beneath our serious attention.

Thus, it would be difficult to excel the ingenuity with which the various small hand-presses, stamping, envelope-folding machines, &c., have been contrived.

In Prussia, the presses of Klein, Forst, and Bohn, and in Bavaria, those of Kœnig and Bauer, will bear close scrutiny, and are equal in every way to anything in the Exhibition.

Wirtemberg is remarkable for the single exhibit of wood-pulp machinery.

The three exhibits made in America are all originalities, and good ones too.

In the British section there is nothing to condemn, and but little deserving of especial praise. Indeed our exhibits in class 59 are very small. However, it must not for a moment be supposed that our standing or position in this class (or, indeed, speaking of machinery only, in any other) can be gauged by what is now shown in the British section of the Paris Exhibition. The space at the disposal of the Commissioners was so small that many applicants were excluded, and the demands of all reduced. With the above

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exceptions, the rest of the world may be said to be nowhere as regards class 59.

In conclusion, I may summarise the exhibits which I think should be specially noticed, and which, if they have been seen, will probably have satisfied those who, though interested in paper-machinery and its belongings, have only had a limited time to devote to its study at the Paris Exhibition of 1867.

Notable exhibits.

France.—Lecoq (20), small presses for general purposes; Poirier (24), envelope-folding machine, machine for making lucifer-match boxes; Ducommun (31), printing machine for stuffs in colours; Gaiffe (32), electrical engraving-machine; Tulpin (40), drying apparatus and others; Dutartre (69), double-colour printing-press; Flamm (86), matrix printing machine; Derriey (87), machine for numbering bank-notes.

Belgium.—Dautrebande and Thiry (1), paper-making machine; Delcambre (2), machines for composing and distributing type.

Prussia.—Klein, Forst, and Bohn (1), printing-presses; Hammel (not in catalogue), machine for printing stuffs in colours.

Wirtemberg.—Voelter and Decker (1), wood-pulp machine.

Bavaria.—Kœnig and Bauer (2), printing-presses.

United States.—Sweet (3), matrix compositor; Degener and Weiler (4), small printing-presses.

England.—Bryan Donkin, (4), machines used in connection with paper-making; Stones (10), wove wires.

## Report on Machines, Instruments, and Processes used in Various Works—(Class 60.)—By Captain Frederick Beaumont, R.E.



Class 60 is defined as machines, instruments, and processes used in various works, and containing coining presses, machines for making buttons, pins, pens, envelopes, packing machines, brush-making machines, machines for making cards, capsules, for affixing lead seals to merchandise, for corking bottles, &c.

Tools for, and processes of, making clockwork, toys, marqueterie, baskets, &c.

By the above title the reader would suppose that Class 60 was one of the most comprehensive in the Exhibition, and, indeed, under its general heading might consistently be included a considerable portion of the whole machinery gallery; in fact, however, it is the least important class of Group VI., and has been arranged apparently to provide a home for all waifs and strays that could not find a lodging elsewhere.

The French are extremely fond of complete arrangements on paper, and they delight in subtleties of organization, generally to the detriment of economy and efficiency. Those who have studied the classification under which the objects were arranged in the French Exhibition will have been struck with the ambiguity which it presented; some things might appropriately have been placed in two, three, or even more different classes. Hence it frequently happened that countries showed similar exhibits in different classes. A machine may be shown by a maker as a specimen of his manufacture, or by the person applying it.

The English wood-working machinery was put in Class 54, machine tools, while the French judged that the proper place for theirs was Class 58, apparatus and processes used in the manufacture of furniture and objects for dwellings. Our exhibitors were, therefore, judged by a jury who put them in competition with a class of machinery requiring a higher order of excellence; the French, by a jury who saw only that the work performed was better and cheaper than could be done by other means. The difficulty would seem to have arisen from too great a subdivision having been attempted, and it no doubt tended to increase the great anomalies which the list of awards showed.

Owing to want of space in Class 60 the French have taken

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their apparatus for making chocolate and for the preparation of tobacco from 60 and put it in Class 51, which contains apparatus used in chemistry, pharmacy, and in tan yards. The list of exhibits in the class under review is very various, and the most dissimilar objects are put side by side; it contains many machines which, though not of the highest merit, are still very important, and play an important part in the economy of manufactures. Amongst them we shall find machines for making lucifer matches, for envelopes, for cigarettes; a machine for executing carving and sculpture, the excellent coining press of Messrs. Cail, a sugar-plum manufactory, a sewing machine for ship's sails (which ought to have been with the other sewing machines), stamping or impression presses, machines for corking bottles, and, finally, clock and watch-makers' and engravers' tools, an industry which is very well represented by Switzerland.

America shows some interesting machines; England has a lead pencil manufactory; and Spain, amongst other minor exhibits, shows a well-designed coining press, made on the system of M. Tonnelier.

Christelle Cornet.

*French Section*, No. 9, Christelle Cornet, exhibits a little machine for cutting out the recess usually formed in compasses to facilitate their being opened by the fingers. Up to the present time this particular work has been done by hand. M. Christelle Cornet has designed this machine, as well as others, to enable him to turn out mathematical instruments at a cheap rate, and though their finish is not very high, the employment of machinery permits good workmanship to be used at a reasonable price. The machine is composed of three parts—the cutting tool, the carriage, and the framework; the latter consists simply of a sort of table, which carries the support of the cutting tool and the arrangement for holding the piece of brass to be operated on. The tool is a serrated disc of hardened steel, which is kept in rotation, and is held in such a way that a vertical motion may be given to it by means of a lever. The legs of the compasses are held between two vice-like grips, which have a movement similar to the slide rest of a lathe. It will be readily understood that the cutting tool being of proper form, the double movement of it (given by depressing the lever which carries it) and the slide rest, would suffice to enable the form required to be cut out. The machine works rapidly and economically, while it ensures its work being always identical.

Presses for stamping and embossing.

No. 40, Steinmetz.—The machines shown by this exhibitor are presses for gilding and pressing leather used for bookbinding and for embossing paper. There are three presses

shown, of which one, the smallest, is moved by hand, and is employed for stamping either with hot or cold dies. The other two are much larger, one being worked by a screw and the other by articulated levers. They can both be driven either by hand or steam power, and are, from their size, especially adapted for paperhangings.

The smaller model is arranged as follows:—There is a solid and strong frame of cast iron, to which is fixed the table and moving parts of the press. The frame carrying the upper die is fixed when the machine is at work, but is made capable of vertical adjustment to suit the varying thickness of the die and the matter to be operated on; in connexion with the upper die are means for its being heated. The pressure is given with the lower die, which is driven by a lever having a knee-joint, to which latter, motion is given by a connecting rod from a crank on a wheel and axle worked by hand. The driving gear is arranged below the working table of the press.

The screw press is different in principle, and though original in some of its details, the whole arrangement is so common as to need little description. Like the press above described, it has a cast-iron frame carrying the lower table, which is moveable, being capable of adjustment by screws. The pressure is put on by a powerful screw, which works in a nut fixed in a strong cross head; this latter is carried by suitable supports attached to the working table, the moving parts are guided by slides, and the upper die is furnished with means by which it can be heated either by gas or otherwise. When the press is to be worked by hand the screw is fixed on to a horizontal flywheel provided with handles, the weight of which is further supplemented by swing balls; when power is to be applied a pulley is substituted for the flywheel, and friction disengaging gear is provided for throwing it in and out of gear at will. This press will produce wall hangings of fairly large size, since its plates are 70 centimetres (somewhat over 27″) square.

The third press is the largest of the three. It is composed, like those just described, of a strong table, on which the moving parts are fixed. The upper plate gives the pressure, and is moved by a framework carrying four rods, which rods are set in motion by a knee-joint arrangement. A pinion on the main driving shaft, which can be thrown out of gear at pleasure, takes into a big toothed wheel, on which is a cranked axle, the connecting rod from which drives through suitable levers, the knee-joint giving the pressure. The table carrying the lower die is supported on the end of a lever heavily counterweighted in such wise that the pressure

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cannot be increased above a certain amount. Arrangements of pipes, with the necessary stop-cocks, are made, so that both the upper and lower plates can be heated. This press is on a larger scale and more powerfully built than the ones previously described; it is principally employed for paperhangings, and when so employed has attached to it an arrangement which delivers the paper in a continuous roll to, and takes it away from the machine. The width of the pattern is limited by that of the machine, but the impression can be reproduced as often as required. The machines sold by M. Steinmetz are solidly made and of good design.

Machinery for making matches.

There is not, apparently, much skill or art required in making a lucifer match, nor is it a great matter when done; but there is an enormous trade done in these articles, and a very considerable amount of ingenuity has been spent in contriving machinery to diminish their cost of production.

In the report on heating and lighting, by Captain Webber, R.E., will be found some interesting statistics on the trade of match making on the continent.

Wood matches are made either round or square; the latter have been cut in France by machinery for a long time, but till now the former have always been imported from Germany, where there are very large manufactories for their production. The wood is cut into lengths of about 27 inches, and then reduced by machinery to the required section; the sticks are sold to the French manufacturer in vats containing 100 bundles of 100 sticks each. The manufacturer then cuts them to the required length previous to dipping, and the subsequent operations. It is a somewhat difficult thing to produce these long thin bits of wood only ·002 millemetres in diameter, and necessitates a very careful choice of wood, and even then considerable waste is unavoidable. Wood containing knots cannot be used.

Rimailho, No. 35.

The machine shown by MM. Rimailho, Brothers, match-makers, has considerable advantages in point of rapidity of production and simplicity, besides which the wood need not originally be very straight, so that the loss is merely that arising from knots. The machine is for cutting the wood, and in place of producing the lengths of 27″ the matches are delivered at once of the proper size. The principle of the machine is to have a fixed set of cutting knives, the circular sharp edges of which are the shape and size required for the match, the wood being presented in blocks and forced against the knives is divided accordingly. The machine for effecting this, and which answers its purpose very well, is as follows:—A table supports a cranked driving shaft, connecting rods from which impart a reciprocating motion to two dummies,

one at each end of the table. These dummies, in their forward strokes, come close up to the edge of the knives. The knives are held in a sort of box, the sides and bottom of which serve as guides for the wood. The action is very simple; a lump of wood of the length of a match, and small enough to go into the box, is fed in by hand, and at each stroke of the machine 10 matches are shaved off; as the main shaft makes 200 turns per minute, each cutter will deliver 2,000 matches per minute, or a total of two millions four hundred thousand per day of 10 hours, less waste.

The next machine is for placing the matches in frames preparatory to their being dipped. They must be so held that they are not much in contact with each other, otherwise they would not get properly covered with sulphur. To accomplish this the matches are ranged in rows, separated by thin slices of wood. Athough the machine of M. Walch, of Paris, does not act entirely automatically, it gives a result much better, in point of economy, than that obtained by the means hitherto employed for putting the matches in press, viz., women and boys. The apparatus consists of a box or reservoir of a convenient length, and of the width corresponding to the length of the matches, in connexion with which is a notched plate, and opposite the notches are a series of wires arranged on a frame. A set of pedals gives the necessary movements to effect the following operations:— 1, to cause a certain number of matches to pass from the reservoir to the notched plate; 2, to rub them by means of a brush into the notches; and 3, to advance a set of rods which thrust the matches forward through the wires, when they appear neatly arranged side by side, and ready for a strip of wood to be put on them by hand. A repetition of the operation causes another lot of matches to be forced forward, and take their places over, and only separated from the last lot by the wooden strip just mentioned; thus, the receiving frame gets rapidly filled with alternate layers of wood and regularly arranged matches. The frame when filled with matches sticking out evenly on each side is first thoroughly dried, then dipped in a sulphur bath and cooled in the air, the drying being completed in a building some distance from human habitations, in order to avoid the deleterious effect of the fumes. When the drying is complete the matches are dipped in phosphorus, which is evenly spread out on an iron table; they are then allowed to dry again in the air, taken from their frames, counted, and packed in bundles ready to be sent to the magazines for sale.

Walch.

For the manufacture of wax lights M. Perrier, of Marseilles, not in the catalogue, shows a machine for cutting them to a proper length, and for preparing them for the

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subsequent operation of applying the sulphur and phosphorus, which is done in the same way that has been described above.

Magica, No. 4, Spain. Machines for wax lights.

Monsieur Martin Magica shows, in the Spanish section, a machine partially automatic, for cutting and arranging wax lights in a frame, ready for dipping. The machine answers its purpose well, and though extremely simple is ingenious. The long strings of waxed cotton, which must previously have taken this form, are wound on drums which turn freely on two horizontal axles placed one behind the other on a frame. All the ends are brought evenly together through holes in a metal plate, to the front of the machine; they pass also between felt-covered rollers, to which an alternative motion is given, which rollers serve the double purpose of drawing the matches from the drums and of ensuring equal lengths being taken; these rollers are moved by hand. The matches thus protruding through the plate find themselves over a strip of wood and under a knife, which is also worked by hand, and cuts them off; the turning of a screw fixes another strip of wood above the layer of matches thus cut, and causes the frame carrying them to descend a distance equal to the thickness of a single layer and its covering, when, by a fresh turn of the handle setting in motion the rollers, the operation can be continued as long as there remains anything on the drums. A dexterous workman can work this machine very rapidly, and the waxed cottons can be wound on the drums by simply turning the latter round by hand.

Belgium. Machine for cutting sugar.

Mons. Wilmotte Devisseber, No. 3, shows a machine for cutting up sugar. The sugar is first divided by a circular saw into rectangular pieces of the required section, the ingots are then placed by hand into the hopper of the machine, which consists of a series of parallel vertical troughs, the bottoms of which are closed by moveable plates, capable of a reciprocating motion, and which advancing from both sides meet in the centre of the line of troughs; above them and at a distance corresponding to the depth of the lumps of sugar required, are a couple of blocks which have similar but opposite motions to those of the plates; the sugar on being introduced passes the blades, but is arrested by the plates, when the same motion which causes the blocks to advance and cut the sugar, causes also the plates to open, and the cut lumps to fall into a receptacle below; the action of the machine is continuous so long as the ingots of sugar are supplied. The gearing driving the knives and plates is simply arranged, and the whole machine is strongly and serviceably built.

England.

Mr. Cohen, No. 2, showed his system of manufacturing

Manufacture of lead pencils.

lead pencils in the annex of the English section of the machinery gallery. In Mr. Cohen's process, mechanical arrangements have little to do and are quite elementary; the wood is first cut into small oblong pieces of the required length, and whose widths correspond to the diameter of a pencil, the pencil is formed by glueing together two of these pieces, one of which is thicker than the other, viz., that in which the groove is cut to receive the lead. Mr. Cohen uses Cumberland lead, which presents particular advantages, but the way in which he deals with it is peculiar. It is extremely difficult to find pencils which have exactly the same degree of hardness, and giving the identical quality of trace, even though marked the same; this arises from unavoidable variations in the quality of the ore. Mr. Cohen thinks he has got over this difficulty in the following manner:—he takes fragments of lead, and having thoroughly pulverized them, solidifies the matter into a hard compact block of the requisite shape. Besides ensuring an equal quality, this enables him to utilize waste pieces, in fact, he states that he principally uses that from a till now abandoned mine in Borrowdale; the composition thus formed appears to possess all the good qualities of pure Cumberlead lead; this system gets over the difficulties of joints, and it excludes the possibility of a difference of quality, while it gives great rigidity and richness of tone. The little bands of lead are placed in the grooves above described, and the upper pieces of wood completing the pencil are fastened on by strong glue, the necessary pressure to ensure perfect adhesion being first given by hand, and then increased by means of force applied through a string; the pencils are then left to dry, when they are given a round form with an ordinary rounding plane; this and the former operation are done by hand, and are of the simplest character; the last thing needed is to mark them with a letter corresponding to the hardness of the lead used, when the pencils are ready for sale.

Money presses.

The hammer was for a long time the only instrument used in the fabrication of money; after that the wing or balanced lever took its place, and was used for many years; later it in its turn was superseded by the continuous action presses, which now do the work of coining in all large mints.

It was only about the year 1834, that Mons. Thonnelier imported into France a system of continuous action presses, which had been then for some time in operation in Munich, and of which he had procured a drawing. Mons. Thonnelier before this time had occupied himself with the construction of machinery for facilitating the operation of coining, and he now showed a copy of the Munich machine at Paris; the

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first one was made by Messrs. Cail and Company, and being imperfectly constructed and of an ill-digested design, though right in principle it gave bad results; by dint of perseverance and many trials, Messrs. Cail succeeded towards the year 1845 in giving the press such a form and obtaining such results as permitted its adoption. It is this machine perfected which was shown in the French section by Messrs. Cail, 24, and was put by them at the disposition of the Imperial Commission, for striking the commemoration medals of the 1867 Exhibition.

The press consists of a strong cast-iron framework, which serves to carry all the working parts; the main driving shaft which is cranked is supported on suitable bearings, one on each side of its centre; the outside end supporting the fly wheel is further carried by an additional bearing attached to the face plate; the fly wheel is mounted between discs in such way that when the resistance exceeds a certain amount it can continue its motion without the shaft; disengaging gear is further provided for throwing the fly wheel altogether clear of the machine, the driving pulley is attached to the spokes of the wheel, and alongside it is a loose pulley; a vertical connecting rod transmits the motion from the crank to the pressure lever; in coining a piece of money it is necessary that three distinct impressions should be given to it, one on each face, and one round the edge, the two former are more simply done than the latter, as the outside of the coin being a circle it necessitates the die being divided; arrangements have also to be made for the advance of the blanks, the withdrawal of the coins, and further for stopping the machine in the event of the supply of blanks becoming exhausted; the face dies are contained in lumps of metal, that indirectly receive the pressure from the connecting rod attached to the crank on the driving axle, the power being multiplied by a knee-jointed lever; there are means irrespective of the stroke of the machine for adjusting the distance apart of the dies, or the position of their stroke; the blanks are delivered and taken away by an arrangement, the principle of which is to cause a plate with a hole in it to move to and fro between the bottom of the hopper containing the blanks and the dies; the action which throws the press out of gear when no blanks are in the hopper depends on the position of a rod, which is altered according as blanks are on their way or not to the dies. The whole machine is automatic in its action, and requires only that the workman should see that the parts are in right order, and the hopper supplied with blanks. The way in which the fly wheel is connected to the press affords great security, since the pressure cannot exceed a certain

amount. A full-sized press, requiring about 3-horse power to drive it, will coin about 80 blanks a minute, and costs 15,000 francs (600*l.*).

Machine for making hooks.

The machine of Mons. Bourgeric, 32, for making hooks, deserves close attention for the excellent way in which it does its work, as well as for the mechanical skill displayed in the arrangements of the parts, which are reduced in number as far as is compatible with the work to be done, a merit not always possessed by French machinery. The form of the machine pleases the eye, and it looks at first sight more like a philosophical instrument than an industrial machine. The apparatus is in size about that of a sewing machine, and it is similarly mounted, only more strongly, on a table carrying the working parts. The hooks are formed of brass wire, either ordinary or galvanized, which is unrolled from a drum and passed between five or six small rollers to give it an equal tension before being presented to the machine; it is then first cut to the proper length, and being raised by pincers, is acted upon in such a way by certain mechanism that an eye is formed at each end, the wire is at the same time forced back in its middle by a blunt knife edge; at this stage of the operation, the wire has been cut, doubled, and an eye formed at each end, two further motions then bend the doubled wire upon itself, and set the hook into shape, which falls completed into a duct leading to the reservoir. All the parts producing the results above described are put in movement by a shaft with cams placed below the table of the machine, and which is driven direct from the prime mover; the result produced, a simple hook, is not much, and yet there must have been a vast amount of ingenuity and patience necessary before the machine could have been produced, working as steadily and well as it did at the Exhibition. If any one doubts it, let him think of the number of distinct motions which are required, each one necessitating a fresh position for the hook; again, the hook while passing from one metal hand to the other could never be let go, as though enough sense, so to speak, might be given to the machine to enable it to hold fast what it had got, it could never be taught to correct a mistake or pick up the wire if it dropped it. When the machine was moving at its usual rate it produced 60 hooks per minute, or 36,000 in a 10-hour day's work. The machine-made hooks have an advantage from the particular form given to them, those ordinarily in use come loose from their eyes when a certain strain is not put upon them, the hooks made by Mons. Bourgeric's machine are somewhat dropped at their ends, which enables them slightly to grip the eyes, although a very small pressure will make them yield.

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Bottle corking machines.

There were in the French section several exhibits of machines for corking bottles, and improved forms of cast-iron trestles for cellar use, these last, though very useful, are not worth special notice. Mons. Cholopin (47) shows the most complete set of machines, from those employed to cork phials up to full-sized wine bottles, each machine has however, a special destination, and in all the principle of action is as follows:—A strong frame holds the bottle, while immediately above its neck is a sort of moveable gland divided into three parts, which can be set up to each other; this gland when opened receives the cork, on being closed the latter is compressed to a size considerably less than that of the neck of the bottle; provision is made to apply force by means of a lever and rod, on the head of the cork thus compressed, forcing it from the gland into the neck of the bottle where it expands; the preservation of all wine depends on good corking, but with champagne it is especially necessary, and the amount of force with which these bottles are corked may be judged from the way in which the heads of their corks usually overlap the lips of the bottles. Mons. Maurice, 45, of Epernay, shows two solidly-built machines for corking champagne bottles only; the bottom of the bottle fits on a tompion, the cork is seized by two conical matrices, which actuated by a cam lever, reduce it to half its original size. In the largest and most powerful machines, Mons. Maurice substitutes for the cam lever working the driving rod, a pinion and rack which is driven by hand through the intervention of a fly wheel; there is also one model shown which completes the operation of compressing the cork and forcing it into the bottle by one movement; the motions are much the same as in the other machines, but the parts are so geared together that they are set in motion by one movement instead of two.

Close to the above apparatus are some machines which are sorts of small rolling mills, they are intended to roll moulds in tin plate, and are very simple and cheap.

Embossing and shading stamp.

Mons. Lheon le Belliez, 26, a maker of artificial flowers, is the inventor and exhibitor of two apparatuses, a cutting press and an embossing or shading press, the use of which tend much to economize labour; the first is for cutting shapes out of paper, velvet, &c., it consists of an ordinary screw press with the cutting tool fixed, the moveable part is a lead disc which is capable of rotation, and thus by continually presenting a new face enables the lead to last a long time; the lead is the only special feature in the machine; the press for shading and embossing is also of similar simple construction, the lower die is fixed and hollow, the upper one giving the pressure moveable and in relief.

Tobacco machines.

There are not many machines shown for cutting or otherwise dealing with tobacco, the Exhibition contains plenty of very fine samples of natural and manufactured produce, but it would seem that this special branch of industry does not afford a great field for inventive genius; the Americans have a cutter, and the French show a most complete and beautifully finished model of the machinery employed in the Imperial tobacco manufactories; these, with a cigarette making machine, are all the tobacco machinery shown.

American tobacco cutter.

Hoglen and Grofflin, 4, in the American section, show a machine for cutting smoking tobacco, which is in its principle of action very similar to an ordinary chaff cutter; an extremely high velocity has been given to the cutting blades, with a view, probably, to ensuring a cleaner cut, but more especially to getting a high production. The apparatus is composed of three parts, the driving gear, the delivery chains, and the knives; the tobacco is placed in a sort of trough, the sides of which are fixed, but whose top and bottom consist of articulated chains very strongly made, in fact of an iron web; these chains are endless, and pass over rollers at either end of the trough, the sides of the latter are inclined inwards, so that the tobacco is compressed more and more as it advances, till when it reaches the knives it occupies a very considerably reduced volume, and exposes a surface of 40 square inches to their action; the cutting blades are two in number, and are very strongly mounted on a couple of backs which are fast to the driving shaft, the knives are fastened on the backs in such a way that they can be readily attached and renewed, a necessary provision, as the sand and grit, which is more or less inseparable from tobacco leaf, blunts the cutters very rapidly. The shaft carrying the cutters makes from 800 to 1,000 revolutions per minute, and they cut in that time from 1,600 to 2,000 slices of tobacco, giving a maximum production of 6,000 lbs. per day, and a minimum of 1,500 lbs., according to the sizes of the slices taken; this is an excessively large production from one machine, and it is due to the exaggerated speed of the knives; it is not unlikely that some disadvantages may be found to accompany this rapidity, as it makes it necessary to enclose the cutters in a close box to avoid the tobacco being tossed out of the reservoir, and thus the action of the knives is removed from supervision, besides which this violent action in throwing the tobacco about causes waste; with tobacco of an average cleanliness, it is necessary to stop about once in five minutes, as the knives appear to blunt more readily at the higher speed, thus a portion of the time gained is lost; there is, however, an advantage that should not be overlooked, viz.,

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that the passage of the tobacco through the machine being rapid it is only compressed for a short time, and thus the leaf does not lose its colour. The thickness of the slices cut is varied by altering the speed of the feeding gear, which can readily be done by changing a couple of wheels. The machine weighs about 3,000 lbs., and requires 4-horse power to drive it; its cost in American currency, and delivered free of charges in New York city, is 1,300 dollars, including half a dozen knives, and duplicates of such portions of the machinery as are specially liable to wear out. Other sizes are made at proportionally reduced rates, down to 300 dollars. The exact multiplier to reduce American currency to English has lately been very uncertain.

Imperial tobacco manufactories.

The director of the French Imperial tobacco manufactories has shown a very complete and well-made set of working models, illustrating the system employed there, together with samples of finished tobacco. They consist of cutters for producing snuff and smoking tobacco, machines for further grinding and preparing tobacco, and torrefiers or driers, together with a machine for wrapping the tobacco in packets. The French cutting machines are very different from the American one described above; they are ordinarily from the Groeffenstaeten workshops, and will not give nearly the same large result. The action of the machine is changed, the rapidly-revolving cutters being substituted by a single blade moving vertically between slides, which cut only during its downward travel. The edge of the blade is inclined, so as to give a drawing cut. The tobacco is fed into a trough, the top and bottom of which consist of endless bands or webs of cloth moved on rollers. There are also intermediate rollers provided, to ensure an equal pressure on the tobacco in its passage to the knives. The motion of the tobacco is intermittent, as were it to advance while the knife is cutting, the machine would be jammed; in fact, the tobacco has to be stationary while being cut, and the feed is given when the knife is clear. This is effected by the rollers or driving gear being worked by a ratchet wheel driven by a pawl from an eccentric on the fly wheel shaft; by altering the throw of the eccentric, the amount of cut taken by the knives can be varied. A noticeable feature in the machine is the arrangement for ensuring a proper feed. If the machine be over or under fed, a roller, lying on the stream of tobacco, is raised or lowered, thus moving an indicating arrow which warns the workman. The apparatus gives good results, produces little waste, and is easy to be looked after.

After smoking tobacco has been cut, it has still to undergo several operations. In the first place it has to be dried.

This is effected in the torrifier or drier of M. Rolland, the director-general of the Imperial manufactories. The apparatus is complete, simple, and would appear to answer its purpose well. It consists of a horizontal cylinder made of plate iron, and of considerable diameter, which is kept slowly rotating while a constant temperature of 75° centigrade is kept up within it. The cylinder, in place of being supported on an axle, is carried by rollers which run on circular bearings; it has also a toothed wheel embracing its circumference at one end, from which motion is communicated. Inside are four screws, which are necessary in order to cause the tobacco first to travel through the machine, and second, to be thoroughly ventilated and separated. The cylinder itself is surrounded with a non-conducting medium, in order to economize the heat and keep it constant. Provision is made, by means of a screw and a couple of worm wheels, to set the drier at any requisite angle; the tobacco is introduced from a sort of hopper or bin placed at one end, and its flow is regulated automatically by means of regulators in such wise that it never occupies more than a certain proportion of the volume of the cylinder; the temperature of the interior is kept up by means of a furnace, a continual flow of tobacco passes through the machine, and it is delivered at the lower end into a sack. The machine can dry from 1,100 to 1,150 lbs. per hour.

After the tobacco has been subject to the action of the torrefier, it passes to another similar one, the object of which is to cool and free it from damp. The construction of this apparatus is much the same as that of the machine described above. There is the same plate iron cylinder turning on rollers with an interior screw, only the furnace is substituted by a suction fan, which, while the tobacco is drawn through the machine, allows a stream of cool air to act on all parts of it. The tobacco enters at one end of the machine warm and dirty, it is delivered at the other cool, clean, and ready for consumption. The apparatus can deliver 2,250 lbs. per hour, something over 10 tons per day of 10 hours' work.

As far as the manufacture is concerned, the tobacco is now finished, and is ready to be put up in packets either by hand or by machine, A full-sized machine is shown by M. Goussil for wrapping up tobacco in parcels of two hectogrammes each. It consists mainly of a circular revolving table, in which are 12 moulds and their accessories; in each one a certain part of the operation of folding is done. It would be difficult to describe without a drawing the exact action of this machine. Though nearly automatic, it is not quite so, requiring for its service six women, three to weigh

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and place the tobacco, and three others, of whom one places the papers forming the envelopes, the second the vignette which is usually put on parcels of tobacco, and the third puts the weighed tobacco in the moulds. The first, who places the papers, takes away the finished packets. One advantage of this machine is the certainty that it gives of all the packets being equally pressed; the pressure can be varied at pleasure. It is driven by power, and might consume some half a horse, not that the work to be performed would necessitate so much exertion, but the machine is somewhat heavy, and there are many pieces to be kept in motion. The machine was stated to afford good results, and give a notable economy over hand labour. The objection to it is its complication and cost. The first is of diminished importance where means of repair are at hand, and the inconvenience of a temporary break-down not very great; and the second ceases to be an objection at all if it be the case that its use ensures a notable economy over hand labour. Under any circumstances the successful substitution of machine for hand labour is a real progress. The work of packing used to be done by men; then, from motives of economy, women were employed, but the nature of the work was very severe, necessitating their being, during working hours, always on their legs; and it was found to produce diseases which obliged them frequently to discontinue altogether that sort of labour.

Machine for rolling cigars.

A small machine was also shown for rolling cigars by the Director of the Imperial manufactories. It consisted of three cylinders. The leaf is first presented to these, between which it passes; a cloth then takes it to another, and having, from being moist, a tendency to adhere to the roll, it is given a turning motion, rolling the leaf in itself; as soon as the cigar is sufficiently thick, it is taken away, and a fresh one commenced.

Cigarette machine.

Mons. Susini (No. 25) has shown an extremely ingenious machine for making paper cigarettes, which is well worth studying, and affords another instance of French ingenuity successfully applied to compass a trifling end under peculiar difficulties. I was anxious to see the machine in operation, but was not able to do so. The superintendent of the class, however, informed me that it had given good results, though its extreme complication was against satisfactory action. It is a first machine, and, like all first attempts, leaving much to be desired, paving the way only to something better. A close inspection of the machine would leave no doubt, however, that a readjustment of the movements might enable an economy of parts to be effected. The light and uncertain nature of the materials, viz., thin paper and

tobacco, make them difficult to manipulate, and as there are so many distinct operations, the difficulty of passing the matter from one part of the machine to another is no very easy one to meet. The machine consists of a sort of cylindrical frame, which serves to carry the distinct apparatus necessary to the various operations, all receiving motion from a pulley on a central shaft driven by the prime mover. The paper is supplied to the machine cut to the proper form, and it is first lifted by means of a vacuum; a small air pump keeps up a partial vacuum in the organ which is required to touch the paper, which is then sucked up, and presented to the side of a cylinder, which rolls it, provision being made for causing the tip of the cigarette to adhere by gum to its body. A second operation folds it at the bottom, and then the form being taken out, the empty case is carried to the mouth of the tobacco hopper, where little by little it receives its charge. A small piston or rammer ensures the tobacco being sufficiently pressed. This last keeps up a rapid reciprocating action, and is set in motion by an eccentric. The details of the machine are so complicated, that even with a drawing it would be somewhat difficult, within the limits of such a report as this, to make the machine clear; but without one it is quite impossible. It is, however, well worth closely looking into, and, I have little doubt, comtains the germ of a machine which will sooner or later be extensively used by cigarette makers. The machine exhibited is said to make 30 cigarettes a minute, one every two seconds, 1,800 an hour, or 18,000 for a 10-hours day's work; a good workman can produce from 2,000 to 3,000 cigarettes a day, and occasionally 4,000. Mons. Susini hopes by perfecting his machine to arrive at a production of double the present amount, or 60 cigarettes per minute, which would give a very large margin over handwork, and enable negro labour to be dispensed with. The value of cigarettes annually consumed in Havanna is said to exceed 10 million francs.

Snuff.

The manufacture of snuff forms also a part of the business of the Imperial manufactories, and as the model exhibited includes machinery for the above, I will describe the principal operations. First of all, the different qualities of tobacco have to be mixed in certain proportions, depending on the sorts of snuff to be produced. Then the tobacco is cut in a machine somewhat similar to the one described above for smoking tobacco, but inasmuch as the same regularity of cut is not required, a greater speed can be given to the knives, and the yield of the machine is proportionably greater. It will cut some 1,800 lbs. per hour. The apparatus consists of rollers for feeding the tobacco forward, and as the leaves

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quit the rollers, they are met by blades attached to a rapidly rotating cylinder of moderate diameter. The thickness of the slices cut is simply arranged by varying the relative speeds of the rollers and cylinders. The tobacco thus cut up is put into large vats for fermentation, where it is left for from four to five or six months; it is only taken out when it has attained a temperature of 70° or 80° centigrade, and has become a dark black colour. In this state the tobacco has almost the appearance of being calcined, and it is then subject to a grinding or rasping process in machines where the work done is entirely mechanical. The grinding mills have somewhat the appearance of coffee mills, and the result of their action is to reduce the leaf more or less to powder. These mills are situated on the first floor of the manufactory, and the tobacco, after being ground, falls by inclined planes from the several shoots into a long horizontal trough, in which an Archimedian screw is constantly turning, which carries the products of all the mills into a receptacle, whence the scoops of a Jacob's ladder take it again to the upper story, delivering it upon sieves, which cause the fine powder to fall through, and sends the larger parts by means of a second Archimedian screw and trough similar to the one in the lower story, to be reground. The mills are thus grinding a mixture composed of that which had previously been inefficiently ground, and such new material as may have been fed in; the operation goes on continuously until the grinding is complete. The snuff is then made, and requires only mellowing, which is done by keeping it in large vats or cases for some two years before it is sent out for consumption.

To complete this explanation of the process and machinery used in the fabrication of snuff and tobacco in the French Imperial manufactories, I ought to add that French-grown tobacco now enters to a considerable extent into the composition of snuffs, and those cheap (and nasty) cigars which are sold in France and smoked to so large an extent.

Machines for cutting the teeth of combs.

The examination of the machine of M. Renout for cutting mechanically the teeth of combs leads me to make a few remarks on the manufacture of combs in general. The machine, though put in the catalogue as in Class 60, was really at work in Class 95, being employed by M. Casella, who exhibited the whole process of making combs from beginning to end. The exhibition which the French made of their different industrial processes of manufacture was extremely interesting, and that portion was always the most crowded in the French section, and indeed in the whole Exhibition. They showed hat making, artificial flower making, and various other industries, introducing the ma-

chinery appertaining to the trade; and though on a small scale, each operation was complete, and the manufacture of a full-sized felt hat could be traced from beginning to end. Some of the industries of remote nations, as the Turks, Egyptians, and Chinese, were scantily represented; but the Europeans, other than the French, showed nothing of the sort, nor was it very likely they should have, when the expense of bringing over workmen and maintaining them in Paris for eight months is borne in mind. Foreign exhibitors would rarely care to show more than that particular part of a trade in which they were original, and from the exhibition of which they might hope to draw custom. They would hardly be likely to see the advantage of instructing the public, by enabling them to catch all the different operations to which their matter is subject before being ready for purchase; but the public would be, and are, through the French, great gainers by such a course, and the feature was a new and noticeable one of the great 1867 Exhibition. Presuming that the inquirer is looking over the rails of 95, at the workmen of M. Casella, engaged in making a horn comb, he would see that the horn, as it comes into the workshop, is first divided into slices, which are placed on a gridiron in a stove heated by gas, when the nature of the horn becomes so far modified that it can be readily split longitudinally, after it has been previously cut transversely. The irregular thicknesses of horn are then placed in a hot-press, the plates of which are heated by steam, and a regularly progressive pressure having been put on, the matter is brought into the condition of smooth and even plates, which are then divided into pieces of the sizes and shapes required, depending on the description of comb to be manufactured.

This operation finished, if a large comb is required, the workman cuts the teeth by means of a circular saw, the mounting of which requires great care. The saw is driven by power, but the comb is presented to it by hand, the eye only guiding as to the depth of cut to be taken and the width the teeth should be apart. When the finer teeth have to be cut, or to cut all the teeth of the less coarse descriptions of combs, the saw is changed and automatic machinery used. For the teeth of combs, whether of ivory, tortoiseshell, or india-rubber, the machine of M. Renout cuts them with a very remarkable degree of exactitude and celerity. It is only the work of a few minutes for it to cut the extremely fine teeth usually given to tortoiseshell combs, and, furthermore, the machine is arranged to cut six combs at the same time.

The general arrangement of the apparatus is simple. A

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circular saw, consisting of a very thin and highly-tempered plate of steel, is kept running between fixed bearings, at some 2,000 turns per minute. The combs are fixed in a rest, which admits of a double movement—first, one of direct advance and return, corresponding to the length of the teeth of the combs, which is effected by making the rest oscillate about a centre; and second, a motion of lateral translation, carrying the centre. This latter results from a screw, to which motion is given by a ratchet wheel. The action of the machine, which is automatic, is as follows:—Presuming a comb or combs to be fixed in the rest, and the machine started, the oscillating movement forces the comb against the constantly revolving saw, cutting it to the proper depth. When the former is brought back clear of the latter, the rachet wheel causes the rest carrying the comb to advance a distance corresponding to a tooth, and the operation repeats itself till all the teeth are cut, when the machine throws itself out of gear. In a 10-hour day's work, 450 combs can be completed, and the action of the machine is so perfect, that the teeth may be cut about a millemètre, or $\frac{1}{25}$ part of an inch apart. To complete the combs, several more operations are necessary. First they are planed; then the big teeth are rounded by hand, and the finer ones are finished by careful rubbing with pumice-stone. This work is done by women, who are responsible for the final polishing and completing the goods for sale.

Tortoiseshell has so high a value that it is found advantageous to imitate it, and a mock tortoiseshell is made which is so like the original, that it necessitates a close scrutiny to detect the imposition. This is done by smearing on the horn a composition with peculiar biting properties, and which imitates those light-coloured, semi-transparent blotches which add so much to the beauty and value of the real shell.

Watch-makers' and jewellers' tools.

There were in Class 60 a great variety of those small but most useful tools, on the accuracy of which watchmakers must depend for the correctness of their work. As might be expected, the Swiss showed successfully in this line, though neither in Switzerland nor elsewhere was there anything which from its novelty was specially remarkable. Perhaps the finest collection of this sort of tool was that exhibited by the associated workmen of Couvet, Neufchâtel, who specially manufacture watchmakers' tools. Most of the other Swiss makers do not make it their trade to manufacture tools only, though they take orders for them in common with their other work.

I will mention some of them whose exhibits appeared most worthy of note.

M. Beraveau, No. 6, and M. Guental, 15, show each of them a splendid collection of tools used by jewellers and watchmakers. The convenient and sensible external forms which had been adopted by these makers for some of their tools, against previous custom, was noticable. They also produced some pincers of a pecular degree of excellence for cutting the wire strings of pianos. Beraveau and Guental.

MM. Bigot, Dumoin show an excellent assortment of tools made from precious stones—notably, ruby files and diamond drills. The manufacture of such tools is an extremely delicate trade, necessitating great skill and care on the part of the workman, together with preciseness. His difficulties are enhanced by the extreme hardness of the material he is operating upon, which of course no other matter will cut. The steel plates for wire-drawing are most advantageously replaced by precious stones, as, however hard the steel may be tempered, the holes will increase in size, so much so that a piece of wire drawn through the same hole is stronger at one end than the other—a matter which either to a jeweller or watchmaker is one of importance. Stone files, too, will touch any steel, and they have long been recognised as useful for repolishing pivots, equalizing the diameters of cylinders, and such like work. Bigot, Dumoin.

Sapphire pivots may be substituted advantageously for the agate ones, on which the needles of compasses are mounted, and other similar purposes.

The manufacture of tools for engraving is represented in the French section by M. Renard (8), the excellence of whose tools is now recognized all over France; indeed, they find their way, too, abroad to a very considerable extent. The first serious attempts made by M. Renard towards putting better tools in the engraver's hands date back as far as 1829, since which time rapid changes have been made. Formerly, engraving on box-wood, which is now so largely used for vignettes and the cheaper descriptions of figures, used to be done by a chisel and hammer, something after the fashion in which furniture is carved. M. Renard substituted a series of light, easily-handled tools, not necessitating a hammer; and this system has now been adopted in nearly all the schools of engraving in France, and since then the cost of engraving has been much reduced, and pictoral illustrations have increased to an enormous extent, even in cheap publications. Not that this has been due entirely to the tools of M. Renard; still he laboured, and that successfully in the right direction. Tools for engraving. Renard.

The roulette or impression roller, by which the practice of engraving is so much facilitated, has been made by M.

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Renard a more efficient instrument. From eleven variations of effect which in France could only be effected by it, the number has now reached 125. In the engraving of pictures of natural history the roulette has been made to play a very important part, and entire engravings have been completed by its means. Besides giving an economy of time and labour amounting to five-sixths, the engraved plates are more durable, and give a longer continuance of good impressions.

These curious little tools requiring to roll smoothly on their axles, are yet some of them not bigger than a pin's head, and are divided into 80 or 100 small conical points. These teeth are shaped at their top according to the work they are required to produce, and they are also disposed differently with respect to each other, though each point must have exactly the same height as its neighbour, otherwise the correctness of the work would be spoiled. M. Renard has shown some roulettes which have been specially prepared to reproduce on steel plates facsimiles of the pencil drawings by great masters which are among the collection in the museum at the Louvre. It would appear impossible to imitate exactly the delicacy of touch which these drawings possess, but a beautiful approximation may be made.

Certain fine dotting tools are shown which are used for engraving those ugly dogs and birds which French sportsmen delight in having on their guns, as also for preparing the plates and rollers used for stamping stuffs and handkerchiefs. Flat and round tools are also included in M. Renard's collection, which can make from two to fifty marks at a time, and which are of great use in expediting work.

The excellence of workmanship embodied in the manufacture of these tools will be recognized when it is remembered that in some of them a millemètre is divided into 50 distinct parts—25 hollows and 25 cutting points, on steel which the nature of the work will only allow to be barely annealed. This subdivision is carried on for a distance of 11 centimètres (nearly 4 inches), and with such exactitude that the hollows and cutting points are all similar, and the latter so even in point of height that they never miss leaving their mark even on the smooth steel engraving plates. Such accuracy as this can only be obtained by the greatest skill and care.

Boune.

M. Boune (No. 14) has a very good show of fine files used by the makers of engraving tools, watchmakers, and jewellers. M. Boune is the successor of a very old house known under the name of Raoul ainé, and established as far back as 1792 This house has employed, and still continues to do

so, only French steel of the best quality, specially cast and prepared for them. M. Boune considers that no steel can surpass for its purpose that which he uses, if it is properly worked at the forge, and annealed, and, above all, if the necessary attention is paid to the tempering. It is hard, and at the same time easily worked and homogeneous.

The workshops of this house are tolerably large, employing 100 hands, and turning out 50,000 to 60,000 dozen files per year.

The files are cut by machinery. The machines used were invented by the founder of the house, but subsequently much improved, though in principle remaining the same. They have been used exclusively in this establishment, as the proprietors would never allow them to be copied. I did not see one of their machines in the Exhibition, so am unable to speak of their merits other than by the work they have done, which is certainly good. For a long time it was considered machines were not applicable to file-cutting, as they could not humour the blow to the steel in the way that a workman's hand could do.

Out of the 50,000 dozen files produced by M. Boune, France takes 30,000, and the remainder are sent abroad, Switzerland taking a large proportion.

M. Weite (13) is also an exhibitor of a very good collection of fine files. Weite.

Switzerland is a serious competitor in the same trade. She sends M. Voutier (19) of Geneva, whose watchmakers' files are in request; and M. Strober (21), from Berne, whose speciality it is to make cheap but good files for ordinary work. Voutier. Stobrer.

In the French section the beautiful lathes of M. Chotoin (21) should be noticed. It is somewhat rare to find in these sort of tools, though they are for producing the most accurate and delicate work, much excellence in their own workmanship, or originality of design. The lathes of M. Chotoin are remarkable for their finish and workmanship, and in design he has aimed at putting into the workman's hand a tool which can be rendered available for several different purposes, by the exchange of certain pieces, in place of necessitating different machines. Chotoin.

In the Swiss section there were some spacious glass cases, well filled with all sorts of small tools. There were none which were not well made; and though I succeeded in finding nothing that was remarkable from its novelty, I think it worth while mentioning a few of those who are perhaps more remarkable than their neighbours for the finish of their tools.

David Louis, Petit Pierre (No. 8), remarkable for excellence of finish. Their lathes for turning pivots are very good.

Petit Pierre.

(8) The drills of this maker are worth noticing, together with their rounding machines.

Vantravers and Petitpierre.

Borel Petitpierre.

Borel Petitpierre (8) makes specially machines for cutting, dividing, and shaping the teeth of wheels. His machines are well designed, and enable teeth of all sorts of wheels or pinions, whether cylindrical or conical, to be cut with the same apparatus.

Bourgeaux and Delameer.

Bourgeaux and Delameer (4), vices and plates for wire-drawing.

Dalphon-Favre.

Dalphon-Favre (6) shows well-made lathes.

Berlie.

Berlie (3) exhibits files of forged steel of exceptionably good quality.

The exhibitors who are classed in the catalogue under the single No. 8 are united workmen of Couvet, who appear to form a sort of co-operative society, which enables them, though working separately, to get the benefit of an organised action in the disposal of their goods.

Darier.

The last exhibitor whom I shall notice is M. Darier, of Geneva (7), who shows lathes adapted for rose and other ornamental turning for the backs of watches, boxes, jewellery, &c. The general construction of these machines is as follows:— The head of the lathe which carries the object to be turned is movable, and carries on its axis a series of copper discs, which discs are serrated or undulated according to the design to be produced. A spring forces the whole lathe-head up to a stop which rolls over the discs; on the axis being turned, the object gets a rotary, and at the same time an oscillating, motion. The tool-holder is mounted in a similar manner as a slide-rest, capable of lateral movement in two directions, and also of an undulating one through discs. In fact the principle consists in superadding to the ordinary circular and rectilinear motions a means by which both work and cutting tool can receive oscillating movements, varied at pleasure by the form of the discs employed. There were several lathes shown, well made and turning out good work; but the same principle ran through them all.

It was very difficult to find out the objects shown in Class 60, as they were mostly small, and in many cases had not been arranged together, but filled odd spaces where there happened to be room. I believe, however, there was nothing of any importance which I did not see.

## Report on Railway Apparatus.—(Class 63.)—By Sir D. Campbell, Bart.

Sir D. Campbell on Railway Apparatus.

The objects exhibited in this class consist principally of locomotives, designs and models of locomotives, railway carriages, goods waggons, signals, turntables, specimens of permanent way, weigh-bridges, models of various systems of brakes and of modes of communication between passengers and guards, specimens of wheels and axles and other ironwork employed in the manufacture of railway rolling stock. Eighteen different countries figure in the official French catalogue as contributing to the Exhibition in this class; but Spain, Portugal, and Norway having failed to send the objects in their respective lists, this number is reduced to 15. The following table shows the actual number of exhibitors from each country:—France, 90; Holland, 5; Belgium, 24; Prussia, 20; Grand Duchy of Baden, 1; Würtemberg, 2; Bavaria, 2; Austria, 22; Switzerland, 2; Sweden, 3; Russia, 2; United States, 7; Great Britain, 24; Canada, 5; total, 214. Objects exhibited.

In several instances, and more particularly in the case of the great French railway companies, which contribute largely to the French department, a considerable number of objects are sent by one exhibitor; and thus the number of "exhibits" is about 50 per cent. in excess of that of the exhibitors.

The most prominent feature in this section of the Exhibition is the great advance made by the Continental workmen in the quality of their workmanship, which is in many instances quite equal to that of the best English workshops. In point of novelty of design there is not very much to be noticed since the Exhibition of 1862. Improvement in Continental workmanship.

The locomotives exhibited are 32 in number. Of these France contributes 11 passenger and goods engines, and two small tank engines for tramways. Belgium sends five, Prussia two, Baden one, Würtemberg one, Bavaria one, Austria three, the United States one, and Great Britain three passenger engines, and two contractors' tank engines. In addition to these, Mr. Fell's engine for the Mont Cenis Railway will probably be in its place before the close of the Exhibition. The completion of it has hitherto been delayed by difficulties experienced in controlling the action

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of the horizontal wheels, working on the central rail, which, it is hoped, have now been overcome.

These constitute, undoubtedly, the most important class of objects exhibited under this head, and in reviewing them it is important to bear in mind the different conditions of the countries, lines of railway, and traffic for which they are intended.

England has a network of canals and the sea, with its fleets of coasting vessels, to supplement her railways in the conveyance of coal and other heavy traffic. On the Continent these aids either do not exist, or do so generally in a very much modified form, so that the heavy traffic is thrown almost entirely on the railways, and such is the accumulation of this species of traffic upon some of the French railways at this moment that, unless the capacity of the trains be increased, there would seem to be no alternative but, at a not very far distant date, to lay down separate lines of rails for the goods traffic, as has already been done to a limited extent on the London and North-western Railway.

English and Foreign locomotives contrasted.

From this circumstance arises the demand for large engines capable of drawing the heaviest possible loads, the limit of which is only fixed by the strength of the waggon couplings or of the waggon frames themselves. On the other hand is to be taken into consideration the increased first cost of these engines, the loss of tractive power whenever they are laid up for the most trifling repair, the greater wear and tear of permanent way occasioned by them, and the increased strength of construction required for the bridges, &c., the weight of the heaviest engine in use being taken as the unit of measurement. And it may be here observed that the ten-wheeled tank engine exhibited by the Paris and Orleans Railway has a weight of 60 tons on a wheel base of only 14 ft. 10½ in. On the whole, the balance of opinion in England, in an economical point of view, is against the use of these monster engines, whose enormous bulk and weight have also found little favour with English observers. A noticeable feature in connexion with these large engines is the extensive use of steel for the boilers, piston rods, connecting and coupling rods, in order to keep down the weight without losing strength.

In contrasting the Continental with the English engines it will be observed that, whereas the latter have only six wheels, the former have frequently eight, and sometimes ten, and even twelve wheels, which are rendered necessary by their greater weight. In England the inside cylinder is largely adopted; and, whether with that or the outside

cylinder, the machinery is simplified as far as possible, and concentrated under the boiler and within the wheels, bringing the line of force as near as may be to the line of traction. In the Continental engines the cylinders are generally outside, and the valve gear carried at the extremity of overhanging crank arms outside the connecting rods of the coupled wheels, and frequently projecting nearly two feet beyond the rails. This system has been adopted partly with the idea of giving greater facility of access to the machinery, and partly from the dread of cranked axles. A symptom of this may be observed in a new engine by Cail and Co., where the crank arms are strengthened by wrought-iron hoops, shrunk on,—a precaution sometimes adopted in England with old engines, but seldom thought necessary for new ones. In the tank engines exhibited the tanks of the Continental engines are generally placed parallel to the sides of the boiler, and overhang; whereas the saddle tank, on top of the boiler, is generally adopted in English engines. This overhanging weight and valve gear must tend to produce more unsteadiness in the engines, and, in the latter case, would seem to give more facility for wear, and consequently for loss of lead, than in those built on the English plan.

In point of workmanship, however, many of the Continental engines are fully equal to those made in English workshops; and it is especially to be remarked that M. Schneider and Co., of the Creusot Ironworks, exhibit a remarkably well-finished express engine made from English drawings for the Great Eastern Railway. It is the sixteenth completed out of an order for 40; the first 15 having been already delivered over to the railway company and accepted by them, the period of warranty for them having expired.

Mr. Kessler, of Esslingen, exhibits a locomotive built by him, from English drawings, for one of our colonies, it being part of an order from the East India Railway Company for 20 engines. The workmanship of this is equally good. These two engines afford incontrovertible proof of the possibility of getting English designs carried out abroad quite as well as at home, and at a cheaper rate.

Railway carriages.

With regard to the display of railway carriages, of which England has failed to send any examples, the general character is very good. The prominent features consist in the universal adoption of the overhung body, by which an additional place is obtained on each seat, which system is also adopted on some railways in England; the substitution

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of iron for wood in the frames; the comfortable fittings of the second and also of the third class carriages, as compared with those in England; the generally defective lighting, and in some cases the total absence of ventilation, more especially in the carriages of the Chemin de Fer de l'Est in France, and in those exhibited in the Prussian section, one of which, moreover, is a smoking carriage. For comfortable fittings, good ventilation and lighting, and general excellence, a carriage in the Belgian section, made by the Compagnie Belge, may be especially noticed. The two-storied carriages exhibited by the Chemin de Fer de l'Est and by M. Vidard are also deserving of notice. They are intended chiefly for suburban traffic, and doubtless in point of economy, if not of comfort, they may be considered successful.

Signals.

The signals exhibited, and especially those in the Prussian section, are not so solidly constructed as those in general use in England; and there is nothing in point of concentration and arrangement of signals and points, with the requisite locking apparatus for the prevention of accidents, to be compared to the model exhibited in the English section by Messrs. Saxby and Farmer. In the French section M. Vignier exhibits a simple system of locking-signals and points, which he introduced in France many years since; but he does not demonstrate the applicability of his plan to a large and complicated system, such as exists at the Charing Cross and Cannon Street stations in London, in and out of which latter station no less than 712 trains with engines passed on Easter Monday last; and in the signal box there, as many as 67 levers for points and signals, with the necessary means of locking, are comprised in one apparatus. In France, however, concentration of signals is often avoided on purpose, and the signal levers are separated by a space of 30 yards, in order to prevent a signalman from giving contradictory signals simultaneously, or, at all events, to ensure his detection in the event of his having done so.

Iron work.

In the Belgian and Austrian sections specimens of wheels, axles, rails, boiler plates, and other wrought-iron work occupy a prominent position. The latter, especially, exhibits some very fine samples of forgings, &c. in Styrian iron, the quality of which cannot be easily excelled. France also exhibits some excellent castings of cylinders, axle-boxes, &c. In the English section this description of work is exhibited in Class 40, where the specimens from the Low-moor, Barrow, Clarence, Atlas, and Earl Dudley's ironworks are to be found.

Permanent way.

A variety of different systems of iron permanent way are exhibited, the majority having iron transverse sleepers of different sections; some, as in the case of the Economic Permanent Way Company, adopting a series of large cast-iron chairs, supporting each rail independently, as used to be the case with the stone blocks, now abandoned in England, but having tie-rods to keep them in gauge. The principal objections to them, generally, appear to be the slightness of the sleepers, (in order to keep down the cost,) and the small hold they have of the ballast, especially in hot countries, for which they are particularly required, where the upper surface of the ballast is more exposed to pulverization than in more temperate regions.

It should be noticed that the "Vignoles," or flat-bottomed rail, is becoming very largely adopted on the Continent, dispensing with cast-iron chairs altogether. At the joints these rails, besides being fished in the usual manner, have a wrought-iron plate on a sleeper under them, and they are secured to the intermediate sleepers simply by bolts having a head formed so as to catch the rail.

Communication between passengers and guards.

Many ingenious modes of communication between passengers and guards are exhibited, consisting of acoustic, pneumatic, and electric signals; the latter forming the great majority, and being largely experimented upon in France, where, however, it is found that, owing to various disturbing causes in reference to the electric connexion between the carriages, about 33 per cent. of the signals attempted to be given do not take effect. In many cases the signal handles in the carriages are protected by glass covers, which the traveller is invited, in case of need, to break with his elbow, in order to reach the handle within. This arrangement, involving the necessity of placing the handle either at the side or in the partition of the carriage, must render the signal practically useless in the event of an assault by a powerful antagonist. It has, however, the effect of deterring nervous or weak-minded, as well as mischievous travellers from giving the signal on frivolous pretexts, while it would answer very well in any of the ordinary cases for which it is desirable to afford the facility of communication with the guard; and it only remains to perfect the means of maintaining the electric current in its integrity, to be able to satisfy the legitimate requirements of the travelling public.

On proceeding to describe in detail the objects exhibited by the various countries, taking them in the order in which they are placed in the French official catalogue, and the position they occupy in the building, the first country on

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the list is France, which, as might have been expected, in completeness and in numbers, as well as in the importance of its contributions, stands pre-eminent. The leading French railways, more especially the Eastern of France and the Paris, Lyons, and Mediterranean railways, have shown a most commendable amount of public spirit, in the scale they have adopted for their contribution to the display made by their country.

France.

The objects exhibited by France are to be found in three different localities, viz., in the outer gallery appropriated to machinery within the building, in a covered annexe, with open space adjoining, in the park, and in the shed devoted to the productions of the Creusot Ironworks.

Locomotives.

Within the building may be observed No. 68 in the catalogue, which is a locomotive engine belonging to the Paris, Lyons, and Mediterranean Railway Company. It is intended for express passenger traffic, on gradients of 1 in 120, for which purpose it has been altered from its original form, by having the boiler lengthened, the driving wheels increased in diameter, and the trailing wheels placed behind the ashpan. It is an excellent, substantial, and well-finished piece of workmanship ; it has six wheels, of which the four leading ones are coupled ; it has inside cylinders, and inside bearings for the coupled wheels, and outside bearings for the trailing wheels. It is provided with screw reversing gear and a species of steam brake, the apparatus for which as well as for the reversing gear, and a specimen of the pistons and of the hollow copper stays for the fire-box used by this company, are separately exhibited on a stand in front of the engine.

This system of steam brake, or "contre vapeur," is that employed on the North of Spain Railway. It is highly approved of by the French engineers, and has been adopted by them to a considerable extent ; and there are several other locomotives exhibited either with the same apparatus or slight modifications of it. It consists in the introduction of a mingled jet of steam and water into the cylinders, the engine being reversed. The water, mixed with the steam, keeps down the temperature and relieves the piston, and is driven back into the boiler without increasing the pressure in it or damaging the cylinders, &c., by the inspiration of impure air, loaded with ashes and grit, from the blast pipe, as is done by reversing under steam in the ordinary way ; while, owing to the small quantity of steam admitted, the shock to the machinery is very slight, and can be reduced to a minimum.

The apparatus consists of two pipes of small diameter,

for water and steam respectively, which are admitted into them from the boiler by means of two small slide valves fixed beside the reversing gear. These valves are worked by screws with crank handles and regulating indexes attached, so that the engine-driver can admit water and steam, in the quantity and proportion he desires, into the pipes, which are united into one at a short distance from the foot plate, and then led along the outside of the boiler and below the smoke box, whence they branch off again to the cylinders on each side.

The principal dimensions of this locomotive, as furnished by the constructors, are—area of fire-grate, 13½ sq. ft.; number of tubes, 158; length of tubes, 13 ft. 1½ in.; interior diameter of tubes, 1⅞ in.; total heating surface, 1,060 sq. ft.; mean diameter of the boiler, 4 ft. 0⅝ in.; diameter of the cylinders, 1 ft. 4½ in.; stroke, 1 ft. 10 in.; wheel base, 15 ft. 1½ in.; diameter of coupled wheels, 5 ft. 10⅞ in.; diameter of trailing wheels, 3 ft. 7¼ in.; weight when loaded, 28¼ tons.

Next in position is No. 71, a six-wheeled engine, all coupled, with a six-wheeled tender engine, also having all the wheels coupled, and built at Graffenstaden, for the Eastern of France Railway, on Sturrock's system. This railway has a very steep and undulating section, especially on the portion between Forbach and Niederbronn, where the ruling gradient for about 40 miles is 1 in 66, with a constant series of ascents and descents. The heavy traffic on this line is principally from the coal basin at one of its extremities, and consequently the greater part of it goes in one direction. If this traffic were worked by a single engine, the load would be limited by the steepest gradient, and for fully one half the distance, where the gradients are flat or descending, the engine would not utilise its whole power; similarly, if a second engine were used as an auxiliary on the steep portions, its power would be wasted on the flat or descending gradients, and it would have a large mileage to run back without a load. In order to meet this economical difficulty, the railway company have adopted this system of engine, with its large boiler and fire-box, capable of supplying steam to the tender engine at the points where its use is required, and where only it is employed as a motive power. The tender weighs when loaded 28 tons, the adhesion of which is thus utilised. It must be observed, however, that this type of engine has been largely employed on the Great Northern Railway in England, where its use is now being abandoned. The principal dimensions of the engine are as follows:—area

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of fire-grate, 26 square ft.; number of tubes, 276; length of tubes, 9 ft. 10 in.; diameter of tubes, $1\frac{3}{4}$ in.; diameter of boiler, 4 ft. 11 in.; total heating surface, 1,422 square ft.; diameter of cylinder, $16\frac{1}{2}$ in.; stroke, $23\frac{5}{8}$ in.; wheel base, 11 ft. $7\frac{3}{4}$ in.; diameter of wheels, 4 ft. $3\frac{1}{4}$ in.; weight, loaded, $34\frac{1}{2}$ tons; weight of tender, loaded, 28 tons. It is provided with screw reversing gear, and the same system of steam brake as that described above on the Paris, Lyons, and Mediterranean Railway locomotive. In order to keep down the weight, the boiler, fire-box cover, axles, and connecting rods are made of steel. It has inside cylinders, and the waste steam from the tender engine escapes directly into the atmosphere.

No. 70 is a powerful goods engine, with six coupled wheels, belonging to the Southern of France Railway Company, and having the peculiarity of being capable of transformation into a passenger engine by the substitution of 5 ft. 3 in. wheels for its ordinary wheels of 4 ft. $3\frac{1}{4}$ in. diameter. The connecting rods work one on a horizontal and the other on a vertical joint, in order to admit of the play in the wheels on going round sharp curves. The springs of the four leading wheels are above the axles; those of the trailing wheels below the axle.

The next in order is No. 63, a large and very powerful goods engine, built by Cail and Co. and the Compagnie de Fives-Lille for the Northern of France Railway. It has eight coupled wheels, with brake blocks on both sides of the trailing wheels. The leading and trailing wheels have from $\frac{3}{8}$ in. to $\frac{5}{8}$ in. lateral play. It has a long fire-box, on the Belpaire system, for burning small coal. The cylinders are outside. The workmanship of this engine is excellent, but the valve gear is very overhanging, and therefore displeasing to an English eye. The principal dimensions are—area of fire-grate, $23\frac{1}{2}$ ft.; number of tubes, 249; length of tubes, 13 ft. $5\frac{1}{2}$ in.; diameter of tubes, $1\frac{7}{8}$ in.; total heating surface, 1,757 sq. ft.; mean diameter of boiler, 4 ft. 11 in.; diameter of cylinders, $19\frac{5}{8}$ in.; stroke, $25\frac{1}{2}$ in.; wheel base, 13 ft. $11\frac{3}{8}$ in.; diameter of wheels, 4 ft. $3\frac{1}{4}$ in.; weight, loaded, $42\frac{1}{2}$ tons. There is also shown, by the same exhibitors, a pair of wheels with Caillet's plan for admitting lateral play and restoring the wheels to their normal position, on entering and leaving sharp curves. It consists of an iron bar placed above the axle, and having at each end horizontal springs, which yield to the pressure on the flanges of the wheels in the curves, but are of sufficient power to restore the wheels to position on that pressure ceasing. They also exhibit a drawing and model

of a draw-bar attached to shifting levers, which work laterally on entering a curve, and keep the line of traction in the direction of the middle of the engine, between the two central pairs of wheels. Also a drawing of a compressed air brake, by M. De Bergue, which consists of a receiver placed on the top of the boiler of the engine, into which, by a simple apparatus, the piston, on the steam being shut off, is made to condense air drawn from the exterior, and not through the smoke-box. This receiver has a safety valve that can be adjusted to the desired pressure, which is the measure of the resistance offered to the course of the piston, and which is gradually increased at each stroke of the piston until the maximum is reached, so that all shock to the machinery is avoided.

No. 65 is a locomotive for mixed traffic, built for the Grand Duchy of Baden railways, at the Graffenstaden works, where the engine above described, belonging to the Eastern of France Railway, was also constructed. It has four coupled wheels, 5 ft. 6 in. in diameter, outside cylinders, and weighs 26 tons, giving the large weight of 13 tons on each pair of wheels. The cranks of the axles are on Hall's plan, being let on to the ends of the axles and forming part of the bearing. The axles and tires are made of Krupp's steel, and the boiler of cast steel. The wheel base is only 8 ft. 6⅜ in., which permits of going round very sharp curves. The workmanship is good.

No. 62 is an express engine belonging to the Paris and Orleans Railway Company, which has been employed since its construction, in December 1864, on the sections from Périgueux to Agen and to Capdenac, the steepest gradient being 1 in 63, and has run a distance of 90,532 miles at a total cost for maintenance of 106*l.* 6*s.* 6*d.*, or about a farthing per mile. The leading wheels have been replaced, but the driving wheels have neither been changed nor turned up. It has six wheels, of which the four hinder ones are coupled, and has outside cylinders and outside overhanging valve gear. It has steel boiler, tires, connecting and piston rods; and is fitted with Arbel's stamped wrought-iron wheels. The fire-box has Tenbrinck's smoke-burning apparatus. It has screw reversing gear; and can take a load of 126 tons up a gradient of 1 in 100, or of ninety tons up 1 in 63.

No. 58 is a specimen of the locomotives used on the tramways of the Commentry ironworks, and is exhibited, not as displaying any novelty, but as a type of engine which the experience of several years has demonstrated to be exceedingly well adapted for traffic of this nature. It

can take 40 empty waggons, each weighing 28 cwt., up a gradient of 1 in 83 at the rate of 16 miles an hour; and 40 waggons of coke up 1 in 220 at the the rate of six miles per hour. The curves on these tramways are in some places of only five chains radius, and this engine has gone round a curve of only two chains radius. The cylinders are placed high, and at an angle, on account of the narrowness of the cuttings and platforms. The company have eleven of these engines; and the annual traffic worked by them amounts to 400,000 tons of coal and coke in one direction, and a return traffic in the other direction of from 20,000 to 25,000 tons.

No. 35 is a tank engine, intended for the goods traffic on the Aurillac and Murat section of the Paris and Orleans Railway, on which there are gradients of 1 in 33 and curves of 15 chains radius. It has ten wheels, all coupled and divided into groups of two pairs each, on each side of the central or driving wheels. The load on each group of wheels is evenly distributed by means of compensating levers. The central wheels are fixed. The first pair on each side of them have a lateral play of $\frac{5}{16}$ in., and the leading and trailing wheels have each $\frac{1}{16}$ in. of lateral play, which is regulated by means of inclined planes on the grease boxes. The framing is inside for the three leading pairs of wheels and outside for the two hinder pairs, and is so constructed in order to give the greatest width possible for the fire-box. The cylinders are outside, with overhanging valve gear. The coupling rods of the leading and trailing wheels have universal joints, to allow for the lateral play, and also for the twist occasioned by the difference in level of the outer and inner rails in sharp curves. There are two fire-doors to facilitate the distribution of the fuel in the fire-box, and the steam brake of the North of Spain Railway is adapted, with a slight modification. The sand box is placed near the base of the chimney, which keeps the sand always dry. This engine can take a load of 150 tons up a gradient of 1 in 33. The principal dimensions are as follow:—Area of fire-grate, $22\frac{1}{4}$ square ft.; number of tubes, 280; interior diameter of tubes, 2 in.; length of tubes, 16 ft. $4\frac{3}{4}$ in.; total heating surface, 2,257 square ft.; mean diameter of the barrel of the boiler, 5 ft. 3 in.; diameter of cylinder, $19\frac{5}{8}$ in.; stroke, $23\frac{5}{8}$ in.; wheel base, 14 ft. $10\frac{1}{2}$ in.; diameter of wheels, 3 ft. $6\frac{1}{8}$ in.; weight, loaded, 59 tons 12 cwt.; empty, 46 tons 15 cwt. The boiler, tires, and piston rods are of cast steel; the frames, axles, and springs of Bessemer steel; and the wheels are stamped by Arbel's process.

Next to this is No. 37, a six-wheeled engine, by Cail and Co., for the Northern of France Railway. In general appearance it is similar to that already described belonging to the Paris, Lyons, and Mediterranean Railway, having the four leading wheels coupled, inside cylinders and bearings for the two leading pairs of wheels and outside bearings for the trailing wheels. It has brake blocks in front of leading and trailing wheels, and the crank-arms of the axle of the driving wheels are strengthened by wrought-iron hoops shrunk on.

Next to this is the only remaining engine in the French section within the building. It is a monster goods engine, made by Gouin, for the Northern of France Railway, on Petiet's system, and appropriately named "Le Titan." It has four outside cylinders and twelve coupled wheels, and a second boiler and large steam chest superimposed. The tubes are passed through the latter, superheating and drying the steam. The chimney is horizontal, and projects beyond the foot plate. A somewhat similar specimen was exhibited in London in 1862. The weight, when loaded, is 58½ tons; when empty, 45½ tons; wheel base, 19 ft. 8¼ in.

In the shed appropriated to the "exhibit" of the Creusot ironworks are three locomotives,—one being a beautifully finished little tank engine for mines or tramways. It is constructed for a gauge of 2 ft. 7½ in., has four coupled wheels, outside cylinders, and overhanging valve gear, can go round curves of 16 yards radius, and up gradients of 1 in 16, and altogether is a very handy little engine. Diameter of cylinders, 8 in.; stroke, 14⅛ in.; wheel base, 4 ft. 9 in.; diameter of wheels, 2 ft. 6 in.; weight when loaded, 6½ tons; empty, 5 tons 4 cwt.

The second is a tank engine, with six coupled wheels, outside cylinders, and overhanging valve gear, and is a specimen of those used in the Creusot works themselves, which are of enormous extent, and give employment to 10,000 workmen. The tank is placed parallel to the boiler and below the top of it, and overhangs considerably. The buffers are provided with double horizontal elliptic springs. The workmanship is very good. The third is an express six-wheeled engine, built from English drawings for the Great Eastern Railway. The workmanship of this engine is also exceedingly good. The driving wheel is 7 ft. 1¼ in. in diameter; leading and trailing wheels, 3 ft. 7¼ in.; wheel base, 15 ft.; diameter of cylinders, 16 ft.; stroke, 24 ft.; weight when loaded, 32 tons; empty,

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29 tons; area of fire-grate, 15½ square ft.; number of tubes, 190; length of tubes, 12 ft.; diameter of tubes, 1⅝ in.; heating surface, 1,123 square ft.; diameter of boiler, 3 ft. 11¼ in. The fire-bars are rounded at the ends, and oscillate so as to free themselves from the ashes; and the fire-grate is convex in form, so as to convey the fuel to the angles of the fire-box. The cylinders are outside, and the eccentrics inside. The trailing wheels have outside bearings, the remainder having inside bearings. The tires are made of Krupp steel, fastened on by Beatty's patent clips. There is a cross spring for the leading wheels; and the driving-wheel springs are below the axle, and are combined with springs made of alternate plates of iron and india-rubber.

Approach to a railway terminus.

Within the main building the Northern of France Railway Company exhibit a model of the very ingenious disposition of the different lines belonging to their system near the entrance to their Paris terminus. From the requirements of the traffic arrangements it was found necessary that the arrival and departure platforms for the main line trains should occupy the extreme right and left of the Paris station, and that those for the Pontoise and Soissons trains should be placed in the intermediate space. At the third kilometre from Paris it was necessary that the Pontoise Railway should cross over to the left, and the Soissons line to the right, of the Chantilly or main line. The goods station at Paris is situated on the right-hand side of the whole system of lines; so that a down goods train to Pontoise must cross the whole of the up and down lines intervening, in order to reach the extreme left or down line to Pontoise. To admit of this, and also of the crossings of the main line by the branches to Pontoise and Soissons without interruption to the traffic in any direction, the disposition of the lines, with the over and under bridges, as shown in the model, was devised. The original gradient was a fall of 1 in 250 from Paris, which remains unaltered as regards the up lines; while, for the down lines, the steepest rising gradient introduced is 1 in 250, and the steepest falling gradient 1 in 83. As originally constructed all these lines were on the same level; but the delay and danger occasioned by the different crossings were so great that the above plan was invented and carried out without interrupting the traffic. The various down lines are shown in the model by copper rails, and the up lines by brass rails, so that the course of each train can easily be traced on it to the proper

destination and the efficacy of the system satisfactorily demonstrated. Similar arrangements, on a larger scale, may be seen at several places in the vicinity of London.

Pneumatic railway.

No. 75 is a working model of a pneumatic railway, designed by M. Bergeron, for the conveyance of passengers from the harbour of Lausanne to the railway station, which is situated at a considerable height above the port, necessitating a steep incline on the short branch line which is to connect these places. It is proposed to construct an iron tube or tunnel, with a sliding door at the lower end. Near this point is to be placed a large receiver, similar to an ordinary gasholder, and connected by a pipe with the interior of the tube immediately within the door. The carriage, by means of a ring of packing which surrounds it, is made to close the tube almost hermetically. The mode of working is as follows:—To ascend the incline—The receiver is raised to its greatest height by means of a hydraulic press worked by a small steam-engine; the carriage is then introduced into the tube, and the sliding door is shut. The water in the hydraulic press is let off, the receiver descends by its own weight, compressing the air behind the carriage, which, being very much lighter than the receiver, is driven forward to its destination. To descend, the process is reversed. The door of the tube at the lower end is shut as before, and the carriage is introduced into the tube at the upper end. The receiver is then raised, and partially exhausts the air within the tube. The pressure of the external atmosphere drives the carriage forward at each stroke of the hydraulic press until the bottom of the incline is reached, while the air still remaining in the tube acts as an atmospheric brake and prevents the carriage from dashing against the door. It is very questionable, however, whether a stationary engine, with the ordinary wire rope, would not be a cheaper and better mode of locomotion. The special recommendation put forward for this plan is, that a very much smaller steam-engine is required to work the hydraulic press than would be required for an incline with a rope.

Safety brakes.

No. 57 is a model of a safety brake for steep inclines, and is adopted on the short branch railway from Lyons to La Croix Rousse. It consists of a pair of friction wheels suspended on each side of the brake van, over the rails, but clear of them. To each friction wheel is attached a pair of clips, which embrace the sides of the rails. The brake is self-acting, in the event of the coupling giving way, when a catch is liberated, allowing the friction wheels to fall on the rails. These wheels, in revolving, work a screw con-

necting each pair of clips, and close them tightly on to the rail, stopping the train in a very few yards. The brake can also be put on by hand from the interior of the guard's van. The rails used are of the Vignoles type, made high in the web.

No. 59 is a specimen of the stationary pumping engines used on the Paris, Lyons, and Mediterranean Railway for supplying the water tanks at the stations. It is a plain, strong piece of work, and well adapted for its purpose. The air vessel is somewhat large, but is made so in order to be fit for the greatest height to which it may be required to pump the water.

No. 45 is a goods van, exhibited by the Eastern of France Railway Company. It is provided with a "Stilmant brake," which consists of a pair of levers, disposed in the form of a horseshoe and jointed in the centre. Within these is placed a wedge, moved vertically by means of bell-crank levers from the interior of the van in the usual way. The brake blocks are attached to rods fixed to the lower ends of the arms of the horseshoe levers. On putting on the brake the wedge is made to descend, expanding the arms of the horseshoe and forcing the blocks against the wheels. This system of brake is extensively used in France.

No. 40 is a guard's van, exhibited by the Eastern of France Railway Company, and is fitted with "Achard's electric brake," for which system the Montyon prize of 2,500f. was awarded in 1865. This brake is a combination of mechanical means with electricity, and consists of a lever fixed with a vertical joint to the under side of the frame; a spring is placed above this lever, which forces the other extremity on to an eccentric cam on the axle of one pair of the van wheels. This cam, in revolving, gives the lever an up-and-down motion; and by means of a short arm working from the end of the lever into a ratchet wheel, each revolution moves on the ratchet wheel one cog. An electro-magnet is fixed to the frame near the extremity of the lever, and when connected with the electric current is sufficiently powerful to counterbalance the weight of the lever and the pressure of the spring, and holds the lever clear of the eccentric cam, which then revolves without touching it. The ratchet wheel is fixed to one extremity of a shaft, to the centre of which is fixed a powerful circular electro-magnet, having on each side of it an iron collar, with a broad, soft iron disc on the side next the electro-magnet. These collars revolve freely round the shaft; but when the electro-magnet is connected with the electric current the soft iron disc adheres firmly to it, and the collars are made to revolve

with the shaft. To these collars are fastened chains, which pass over a pulley secured to the frame, are then led round a sheave at the extremity of the lever which works the brake block, and are finally fastened to a hook in the frame. The electro-magnet on the ratchet-wheel shaft is made of such power that the force of adhesion to it of the collar discs is greater than that required to lock the wheels of the van. On interrupting the main electric current, which is effected by means of commutators placed on the engine and in the guards' vans, and also by any part of the train becoming detached, the magnet suspending the lever ceases to act, the lever falls on the eccentric cam, and at each revolution of the wheels the ratchet wheel is moved round one cog, carrying with it the circular magnet to which the collars adhere, and winding up the chains which are attached to the latter. These chains on being tightened press the brake blocks on the wheels; and in order to prevent their being locked a dynamometer is attached to the hook, by which the chains are fastened to the frame, and is adjusted so as to yield before arriving at the pressure required to lock the wheels, and in so doing it moves a commutator which cuts off the electric current from the circular magnet on the shaft. The collars are then liberated and the chains become unwound, and the pressure is taken off the brake blocks, on which the dynamometer resumes its first position, the current is restored, and the brakes are put on again and again until the train is stopped. There are other modifications for maintaining a given pressure short of locking the wheels.

Weigh-bridges.

No. 61 is a weigh-bridge for railway carriages, capable of weighing 30 tons. It is made by M. Sagnier and Co., and has a simple apparatus for locking, which consists of a shaft at each end, supported on strong pedestals, and made to revolve simultaneously by pulling over a lever placed near the steelyard. On both ends of these shafts are eccentric cams, which when the shafts are turned round come under the longitudinal bearers of the weigh-bridge and take the weight off the weighing machinery, so that it may be run over by engines without injury.

M. Sagnier also exhibits a good weighing machine for adjusting the springs of locomotives. It has ten separate bridges, with the steelyards brought close together. By this means the ten wheels of an engine may be simultaneously weighed and the springs adjusted.

Communication between passengers and guard.

No. 28 is a model of electric apparatus, by M. Prudhomme, for communication between passengers and guard. The couplings consist of short lengths of insulated wire at-

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tached to galvanised rings, which are hooked on to bronze spring hooks at the end of each carriage. These hooks have insulated wires connecting them under the frames of the carriages. This system is extensively adopted in France, and especially on the Chemin de Fer du Nord. A perfect coupling is, however, yet to be discovered, as a large percentage of attempted signals fail.

No. 32. M. Vivaux and Co. exhibit under this number a quantity of beautifully sharp and clean castings of cylinders and grease boxes; also an axle-box with apparatus for using water instead of grease. It consists of a disc at the end of the axle with projections on it, which catch up the water in revolving and make it pass over the axle.

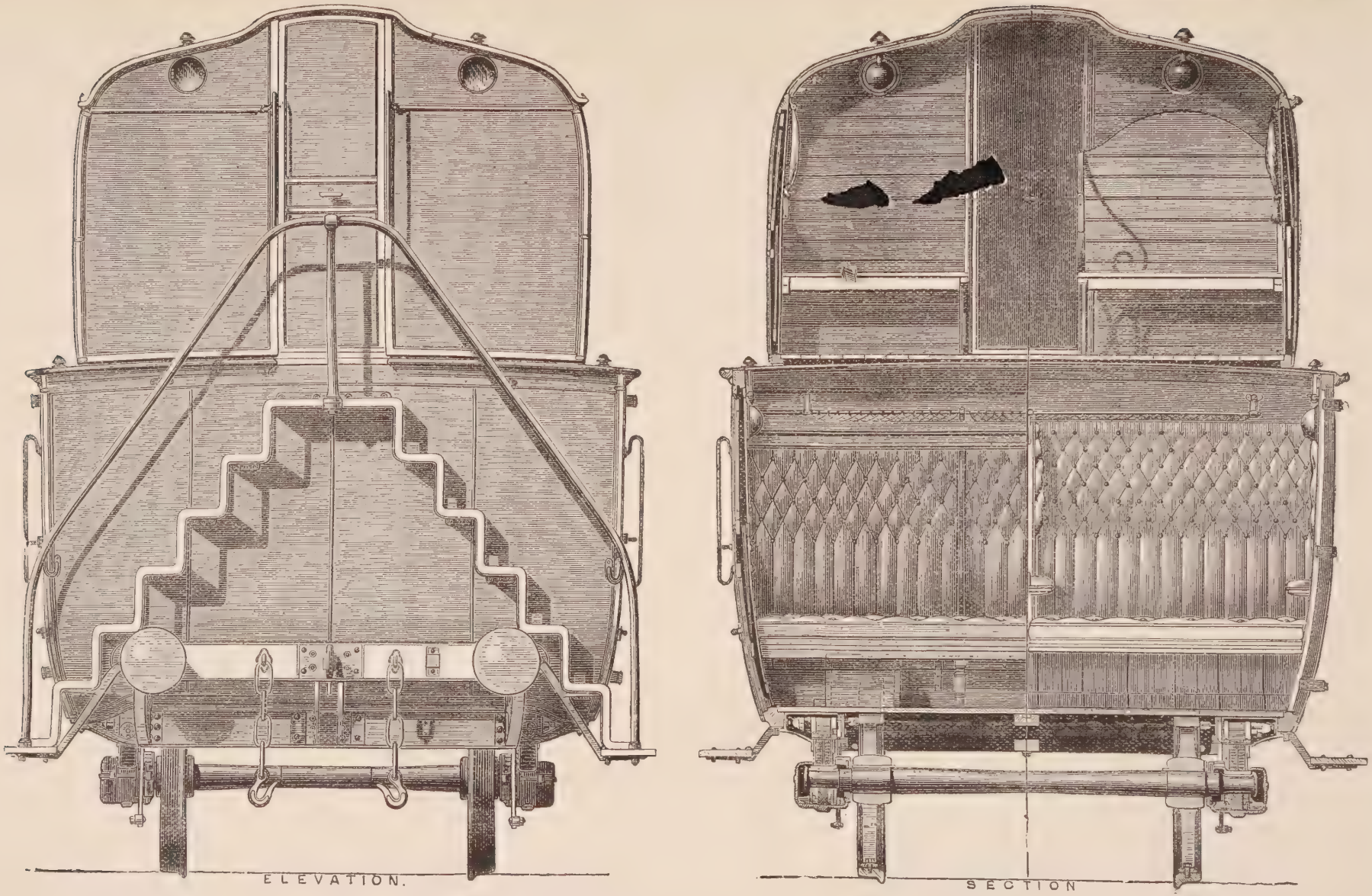
Stamped wheels.

No. 34. Messrs. Arbel-Deflassieux and Co. exhibit some excellent wrought-iron stamped railway wheels, made by their process, which consists in putting the pieces of the wheels together cold in a matrix. They are then raised to a welding heat, and by means of a superimposed die and a 24-ton steam hammer are stamped into one piece. These wheels have a great reputation in France, where they are extensively used. A number of drawings and models of articulated or bogie-frame engines are exhibited. No. 13, by M. Thouvenot, is a drawing of a double engine, with four cylinders, intended for the passage of the Alps, and is somewhat similar to that of Mr. Fairlie. There is attached to it a modification, intended for a line with a central rail, on the Mont Cenis system.

No. 24 is a model by M. Gouin, in conjunction with M. Boutmy, of an articulated engine with ten coupled wheels on two bogie frames. The front one carries the engine, and has six coupled wheels; the hinder one carries the tender, and has four coupled wheels. Between the latter is an independent axle, worked by a connecting rod from the driving wheel. The crank-arms of this axle work in a slot in the coupling rods of the four trailing wheels, and communicate the motion to them while admitting any amount of lateral play.

Railway carriages.

No. 42 is a first-class carriage exhibited by the Eastern of France Railway Company. It has two ordinary compartments, with eight places in each, and a deep coupé with three places in it. The backs of the seats in the coupé are made to fold down forwards, forming beds, with comfortable mattresses on them, and the additional space afforded by the recesses into which these beds fit give ample room to recline at full length. The amount charged for these "coupé lits" is 40 or 50 per cent. higher than the ordinary first-class fare. It is greatly to be desired that a similar




4. END VIEW AND SECTION OF DOUBLE-STORIED CARRIAGE ON THE EASTERN OF FRANCE RAILWAY.

system should be introduced into England for the night mail trains. The ordinary compartments have an arm in the centre of each seat which folds up out of the way, so that passengers may also recline in them if there be room. This carriage is very well finished and is most comfortable, but has one serious drawback, which is the total absence of ventilators; and the sides of the doors are, moreover, provided with strips of india-rubber, more effectually to exclude the external atmosphere. The reason assigned for this is that, owing to the numerous disputes among the travellers as to the use of the ventilators above the doors, the company have determined to settle the question by dispensing with them, thus leaving the ventilation to be managed by lowering the windows. Whether this mode will tend to promote greater harmony among travellers is more than doubtful.

No. 41 is a double-storied carriage exhibited by the same company, designed by M. Vidard, and principally intended for suburban traffic, where the speed of the trains is not great; but this type of carriage is also destined for the conveyance of excursionists from Strasbourg to the Paris Exhibition. The lower story contains a first-class compartment for eight passengers; two second-class compartments, carrying twenty passengers, and a third-class compartment for women, holding ten passengers. The upper story, which is reached by an iron stair, with a light iron handrailing, at each end, has a passage down the centre with ten seats for two persons each, on both sides. The second-class compartments are very comfortably fitted up with plain, well-stuffed cushions and backs, and have hat nets over the seats. The third-class compartments are also comfortable, having curved seats and backs, though without cushions; they are well glazed, and have curtains to the windows. The lighting, however, is poor, and there are no ventilators. In order to keep the centre of gravity as low as possible, the two stories are each made only 5 ft. 5 in. high in the centre, and the heat, especially in summer, must be intense in them. The oscillation with a heavy top load must be very great, and they cannot be safe carriages to run at high speed.

The longitudinal bearers of the frame are of iron, and are curved upwards and outwards at the ends to receive the buffer boards, which are fitted with horizontal springs, the ends receiving the buffers, and the centre being coupled to the draw bar. The transverse bearers at the ends are of iron, and the intermediate ones of wood. The wheels come up through the floor under the seats, the divisions of the compartments corresponding exactly with the centre of each of

the two pairs of wheels. The cost of this carriage is about 440*l.*

No. 49 is a somewhat similar double-storied composite carriage, built for M. Vidard by Gargan and Co., holding eight first-class, 10 second-class, and 36 third-class passengers. It is provided with a brake, weighs $5\frac{3}{4}$ tons, and costs about 320*l.*

The above comprise the principal objects exhibited by France within the building.

The annexe in the park is specially devoted to railway carriages, and the various articles employed in their construction and fittings.

M. Bonnefond and Co. exhibit, under the numbers 132 and 138, a second-class carriage for the Eastern of France Railway, and a third-class carriage for the Paris and Orleans Railway; the former a good plain carriage, but deficient in ventilation; the latter is also comfortable and well constructed, and has not the above defect.

Delettrez and Co. exhibit, No. 140, a very good third-class carriage for the Eastern of France Railway, with curved seats, and backs, and partitions between the passengers, but having the defect of want of ventilation common to all the carriages made for this railway. They also exhibit No. 139, an excellent wooden-framed second-class carriage for the Western of France Railway, with most comfortably stuffed seats and backs. The wheels are solid, and have brakes on all of them.

Chevalier, Cheilus, and Co. exhibit No. 137, a good iron framed first-class six-wheeled carriage for the Paris, Lyons, and Mediterranean Railway. It has three compartments and a coupé. The central arms in the seats fold up. The bottom is covered with sheet iron, the panels on the sides and ends with Bessemer steel, and the roof with sheet copper to prevent fire. The weight is nine tons, and the cost of it 465*l.* It is provided with a pneumatic apparatus for communicating between passengers and guard, which consists of a bell rung by means of a weight and pulley, working over a drum with cog wheels attached. The weight is kept in a state of rest by means of a detent, which is liberated by the withdrawal of the projecting end of the piston of a small cylinder. This cylinder communicates by means of flexible tubes with small air pumps in the different compartments. On working these a partial vacuum is created behind the piston, which is then moved forward in the cylinder by the pressure of the external atmosphere. The detent is thus liberated, and the weight descending

causes the bell to ring. The same firm also exhibit a very well-built travelling post-office of the French official pattern. It is unprovided with any machinery for giving or receiving the mail bags when in motion; the stools and chairs in it are not fixtures, as in the English travelling post-office; and it is warmed by a stove with the pipe passing through the roof, which would aggravate the results of a collision; and the edges of the desks and other projections are not protected by stuffing. These defects might easily be remedied; it is in other respects a very good carriage.

No. 135 is an earth waggon, by Suc-Chauvin and Co., turning on a central pivot, and being thus enabled to tip on all four sides. It has a complicated system of levers to open the tailboard, which has, moreover, the defect of being hinged on the top, and altogether seems easily put out of order.

Messieurs Chatel, Luchaire, and Masson exhibit specimens of the different railway lamps in use in France, which do not present any very remarkable feature.

Signals.

In the open space in the park M. Vignier exhibits his system for locking signals and points, which consists of a series of bolts moved by bell-crank levers, and fitting respectively into holes in the levers for working the points and signals. They are so adjusted that the act of working the lever of one signal moves the requisite bolts into the apertures made for the purpose in the levers of all the other signals which might occasion danger, and locks them. This system is very simple and effective, and was introduced into France by M. Vignier thirteen years ago. From all the bolts being placed in a horizontal plane, it takes up a good deal of space.

There are here exhibited also specimens of all the signals in use on the French railways. The majority of them being disc signals.

No. 110 is a good self-acting distant signal by Dietrich and Co. It is put on by a passing train, and is worked by means of the circular arm of a lever which comes up beside the rail, and is placed in such a position that the flange of the first wheel passing over it depresses it, liberating the catch of a counterpoise, which puts on the signal, and, by means of a wire, gives intimation to the signalman at the station that the signal is on. The signal can be reset by a second wire from the station.

M. Brame exhibits a signal worked in a similar manner by the train itself, but the signal is given by means of electricity instead of by a counterpoise.

Turn-table

No. 93 is a 39-ft. engine turn-table, exhibited by the

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Paris, Lyons, and Mediterranean Railway Company. It can be moved either by hand or by a small donkey engine upon it. It works on four sets of large rollers, three in each set, with compensating levers.

No. 96 is a good articulated truck by M. Vidard, built at the works of Gargan and Co. It is capable of carrying a load of 16 tons, and is intended for the conveyance of timber, rails, and other lengthy goods on lines with sharp curves. It weighs only 6½ tons when empty; and, its load being 16 tons, M. Vidard claims a great economy in tractive power for this description of waggon with any kind of goods.

Fruit-tree hedge.

M. Tricotel shows here a fruit-tree hedge, having wooden standards, with a lattice-work of laths between them, and three horizontal wires, along which the fruit trees are trained. M. Tricotel asserts that it can be erected at a total cost of 11*d.* per lineal yard. Although it might possibly suffice for those portions of France where no cattle are allowed to go at large without a herd, and though it would probably be highly appreciated by the platelayers on the railways, it is not of so substantial a character as to fulfil the requirements of the Board of Trade in England.

Holland.

Railway carriages.

The next country in the catalogue is Holland, and the objects exhibited by it consist chiefly of railway carriages. The State Railway Company exhibits a composite carriage, with three second-class compartments and a first-class coupé at each end. The coupés and one second-class compartment are for the use of smokers. It is very comfortably fitted up, and has small windows in the partitions, with a blind on each side. These are no doubt intended as a sort of protection for travellers, but are a more probable source of annoyance than of security. The frame has iron longitudinal and wooden cross bearers. They also exhibit a very good iron guard's-van, with sliding doors. At the end of the van a seat for the guard is placed on each side, with the brake handle between them. In front of each of these seats there is a window, and also projecting windows above and at the side, with mirrors so disposed that, without moving from his seat, the guard can see behind the train, and also the tops and sides of the carriages, while at the same time the brake handle is at his elbow.

M. Beignes exhibits an excellent composite carriage, with two first and two second-class compartments, which are lofty and well ventilated. The first-class compartments are very well fitted up, and the only fault of those of the second class is, that they are so comfortable as to render the first class superfluous.

Next in order is Belgium, whose "exhibit" is distributed among two annexes and an open space in the park, and ranks next in importance to that of France.



The Compagnie Belge exhibit a locomotive with six coupled wheels, for the Luxemburg Railway, having inside cylinders and outside bearings. The eccentric rods are very short, and thereby have to work at a sharp angle. It weighs 36 tons when loaded and 31½ tons when empty, and is a plain, good engine.

Railway carriages.

They also exhibit an excellent iron covered goods waggon, on four cast-iron wheels, with axle-boxes on Gobert's system. It has a door and communicating platform at each end, and four vertically sliding ventilating windows in each side, the openings of which are protected by gratings. It has a wooden floor, and E iron at the joints of all the iron plates. It is fitted with spiral draw springs for the central and side chains, weighs 6¾ tons, carries a load of 10 tons, and costs 192*l.* The same company exhibits a composite carriage, which is the most perfect in the Exhibition. It has a first, second, and third class compartment, and also a first-class coupé, which is fitted up with morocco leather. The second-class compartment has open cane-work seats and back. The steps are of metal, and are roughened to prevent slipping. The doors are provided with slips of india-rubber round the joints to keep out draughts. The compartments are lofty and well-lighted, and have ventilators round the lamps and over the doors. The frame is of iron. The carriage weighs 9 tons, holds 32 passengers, and costs 600*l.*

Locomotives.

The Société St. Léonard exhibit a ten-wheeled tank engine for the goods traffic on the Santander Railway. It is calculated to take a load of 200 tons up gradients of 1 in 50, and round curves of less than 15 chains radius. The six hind wheels are coupled, and the four front wheels are on a bogie frame. The bogie frame is connected with the engine by means of a pivot working with a spherical universal joint in the centre of the frame, and having fixed to the top of it a horizontal lever, the other extremity of which is articulated to a fixed point below the boiler. The smoke-box is carried on the pivot end of the lever by two cast-steel wedges, which ride on double inclined planes on top of the lever above the pivot. By means of the rotation on the pivot and the lateral play on the inclined planes, the axles of the bogie are kept parallel to the radius of the curves and its centre in the axis of the line of rails. The trailing wheels have also $\frac{9}{16}$ in. of lateral play. The cylinders are outside, and placed at an angle of 16 deg. The valve gear is worked by Walschaert's system of link motion—that is, by a single

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eccentric and by a series of levers from the crosshead of the piston. This plan is stated by the Belgian engineers to work well; but it looks very complicated, and as if very little wear would occasion loss of lead. The draw bar has lateral play working in a slot in the buffer board, and is led under the axle of the driving wheels to the centre of the engine, where it is articulated. The tank overhangs, and is parallel to and below the level of the top of the boiler. The principal dimensions are:—Area of fire-grate, 28½ square feet; number of tubes, 200; length of tubes, 13 ft. 6¼ in.; diameter of tubes, 2 in.; diameter of boiler, 4 ft. 3$\frac{3}{16}$ in.; total heating surface, 1,490 square feet; diameter of cylinders, 18⅛ in.; stroke, 24 in.; diameter of coupled wheels, 3 ft. 11¼ in.; weight, when loaded, 44¼ tons; when empty, 35½ tons.

The Couillet Company exhibit a tank engine for working coal traffic up steep gradients and on sharp curves. It has four wheels, which are coupled to an intermediate axle, driven by connecting rods from the pistons. The fire-box is on Belpaire's system for burning small coals. The cylinders are inside and inclined, and the valve gear is on Walschaert's system. It is provided with a steel slipper brake, which works on the rails; and it weighs 23 tons when loaded, and 19 tons when empty.

Cockerill and Co. exhibit a six-wheeled express engine, made at their works in less than three months. The four hind wheels are coupled. It has a Belpaire fire-box, screw reversing gear, inside cylinders, outside bearings for all the wheels, and additional inside bearings for the driving wheels, wrought-iron boiler, and Bessemer steel tires. The springs of the coupled wheels have compensating levers. Every part of the engine, including the steel tires and plates, was made in Messrs. Cockerill's works; and it is a good, strong, and serviceable piece of work.

Axle boxes.

M. Haeck shows an axle-box for lubricating carriage axles with oil, water, and tallow. The apparatus consists of a small friction wheel, which is pressed against the axle by a spiral spring within the box, the lower part of which is filled with tallow, oil, and water. The friction wheel in revolving sends the oil and water over the axle; and if the heat becomes excessive the tallow is melted and comes into play as a lubricant, solidifying again when the temperature becomes lowered.

The Société d'Ougrée exhibit some very good specimens of wheels, axles, and tires. The Clabecq ironworks send specimens of boiler plates and locomotive frames; and M. Blondieaux exhibits samples of the different rails used

in Belgium. All the latter class of "exhibits" have been treated in the English section as manufactured iron, and have been shown in class 40.



The principal objects exhibited by Prussia and the North German States are—



No. 1, a very well finished, plain, and serviceable six-wheeled locomotive, by Borsig, of Berlin. The four hind wheels are coupled, and the springs have compensating levers. The cylinders and bearings are outside. The tender has six wheels and compensating levers, with brake blocks on both sides of all the wheels. The principal dimensions are:—Area of fire-grate, 18½ square feet; number of tubes, 194; length of tubes, 11 ft. 4 in.; diameter of tubes, 1⅝ in.; total heating surface, 1,000 square feet; diameter of boiler, 4 ft. 4 in.; diameter of coupled wheels, 5 ft.; wheel base, 13 ft. 4⅝ in.; diameter of cylinders, 16 in.; stroke, 22 in.; weight, when loaded, 34¾ tons; when empty 30½ tons.

No. 2 is a six-wheeled express engine by Hartmann, of Chemnitz, in Saxony. The four hind wheels are 6 ft. in diameter, and are coupled, the trailing wheels projecting above the foot plate. The buffer board turns vertically on a central pivot, to allow the pistons to be examined. M. Hartmann also exhibits a portable machine, invented by Elnhardt, for weighing separately the wheels of engines and carriages. It consists of a short lever, with the fulcrum resting on the rail itself, and capable of modification, so as to suit any section of rail. The weight is ascertained by means of a long steelyard with graduated scale and shifting weights. For carriages a smaller head weight and a second scale, marked on the steelyard, are used. It is a very handy little instrument, and gives the weight on the wheel of an engine to within 20 lbs.



The Company for the Manufacture of Railway Material at Berlin exhibit two composite passenger carriages for the Stettin and Halle-Cassel railways, with retiring rooms and conveniences for invalid travellers. They have no ventilators, and are warmed by means of boxes for hot sand, which are placed under the seats from the exterior. The second-class fittings are very good. They also exhibit a travelling railway post-office, with apparatus for taking up the mail bags without stopping. The internal arrangements are not well designed; the counterpoise for the net projects awkwardly into the interior, and there are several other projections unprotected by stuffing. It is warmed by a stove which is fed from the roof of the carriage.

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Lüders, of Goerlitz, exhibits a composite carriage, with two compartments for smoking in, and a ladies' second-class compartment, which is fitted up more handsomely than the first class. There is no provision for ventilation.

Several goods and coal waggons are exhibited, the best of which is an iron waggon, by Schmidt and Co., of Breslau, for a Polish railway. It weighs 5 tons, and carries a load of $10\frac{1}{2}$ tons.

The Bochum ironworks exhibit a magnificent specimen of casting in steel, which consists of 22 railway carriage wheels cast in one piece.

The Eastern Railway Company exhibit an apparatus for indicating the regularity of speed or of tractive force used between stations. It consists of a dynamometer worked by levers instead of springs, which is attached to the draw bar of the tender, and indicates the strain on it by means of a pencil point on a revolving strip of paper.

Grand Duchy of Baden. Locomotive.

The Grand Duchy of Baden is represented by a locomotive from the Carlsruhe works. It has six coupled wheels, outside cylinders, and inside valve gear. The slide-valve spindle is curved over the axle of the leading wheels. The connecting rods are very light, but the workmanship of the engine is good.

Würtemberg. Locomotive.

From Würtemberg M. Kessler exhibits a six-wheeled locomotive made at Esslingen for the East India Railway Company. It is built from English drawings and the workmanship is excellent. The four hind wheels are coupled; the frame is inside, and straight from end to end; the cylinders are outside; the tires are of steel and are bolted between each spoke. It is provided with screw reversing gear, and has a large awning.

Bavaria. Locomotive.

Bavaria is represented by M. Krauss, who exhibits a four-wheeled tank engine with the tank under the boiler and forming the frame. The cylinders are outside, and the valve gear is overhanging. This is the first engine built at M. Krauss's works, and hence there is room for improvement in the workmanship.

Austria. Locomotives.

In the Austrian section the exhibition is largely composed of specimens of rails, wheels, tires, and axles, in steel and Styrian iron, the quality of which is excellent. M. Sigl, of Vienna, sends a six wheeled locomotive for a railway at Warsaw. The four hind wheels are coupled, and have compensating levers. The cylinders are outside, and also the bearings, which are made on Hall's system, with the cranks let on to the axles. The slide-valve spindles have no guides, on Sharpe Stewart's plan. The

workmanship and general plan of the engine is good. He also exhibits an engine with eight coupled wheels for a Russian railway of the 5-ft. gauge. It is intended to burn wood, and has a funnel-shaped chimney. The valve gear is very overhanging.

The State Railway Company exhibit "the Steierdorff," a ten-wheeled engine, which was exhibited in London in 1862, and has worked satisfactorily since then, with a slight modification in the tender. It was designed for the coal traffic on the railway from Oravicza to Steierdorff, on which there is a gradient, ten miles in length, of 1 in 50, with numerous $5\frac{1}{2}$-chain curves; and the rails only weigh 52 lbs. to the yard. The engine is carried on two bogie frames, the leading one having six coupled wheels and the hind one four coupled wheels, and an intermediate axle coupled to the driving wheels on the leading bogie frame, and communicating the motion to the trailing wheels by means of a short vertical connecting rod, with universal joints, to admit of the lateral play.

The bogie frames are connected with each other by a spherical universal joint. The smoke-box is fixed to the leading bogie frame, and the boiler is supported by three other cross frames on it. The fire-box rides on a roller on the hind bogie, which supports it while allowing it to move laterally. The fuel is carried in bunkers on the hind bogie, but the water is now placed in a guard's van behind the engine, fitted with a tank for the purpose. This van is also articulated to the engine by a spherical universal joint, and is provided with a powerful brake, which can be reached by the stoker from the engine. The engine is also provided with a brake on the four hind wheels of the leading bogie, which is worked by steam, and has cylinders for the purpose under the engine. The machinery of this engine is very complicated, and from the great number of parts the friction must be enormous. The principal dimensions are:—Area of fire-grate, 15 square feet; number of tubes, 158; length of tubes, 14 ft. $6\frac{1}{4}$ in.; diameter of tubes, 2 in.; total heating surface, 1,321 square feet; diameter of boiler, 4 ft.; diameter of cylinders, $18\frac{3}{16}$ in.; stroke, $24\frac{1}{2}$ in.; diameter of wheels, 3 ft. $3\frac{3}{8}$ in.; wheel base of both bogies and of guard's van, 7 ft. 3 in. each. Weight when loaded—engine, $41\frac{3}{4}$ tons; guard's van, with water, 15 tons. The coupling rods work very close to the ground.

Signals.

M. Bender exhibits an arrow-headed signal, which indicates the direction for which the points are open. The

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arrow head is coloured red and white, and is illuminated at night by a lamp, with reflecting mirrors on the outside. Its sides are curved, so as to reflect the rays back from the mirrors in parallel lines, and to prevent the colours being confused at a distance, so that the day signal and the night signal are identical.

Iron-work.

M. Ganz shows a sample of chilled cast-iron crossings, which are largely used in Austria, and some chilled wheels, one of which is exhibited to show the effect upon it of 13 years' constant wear. The metal is very good.

The Southern Railway Company exhibit some specimens of steel tires and axles, and of rails twisted when cold, made of Styrian iron alone, and also with Bessemer steel tops, and some of Bessemer steel altogether.

The specimens of iron and steel work sent by Henkel, of Donnersmark; the Neuberg Ironworks, and Prince Lichtenstein; and the steel springs by Mayer and the Eibinvald Ironworks are well worthy of inspection and, in general, the quality of the materials of this description exhibited by Austria is very good.

Switzerland.

Switzerland is represented by the Société Industrielle de Neuhausen, which exhibits a light carriage in two compartments, for second and third class passengers, with a platform at each end and a central passage throughout. It is comfortably fitted up; but the above arrangement has the disadvantage of involving a waste of seat space. This carriage is to be found in an annexe in the park.

Railway carriage.

Sweden.

Sweden has three representatives, of whom the principal is Zethelius, of Westeräs-Surahammar, who exhibits some good wheels, axles, and tires.

Russia.

In the Russian section there are some good cast-steel axles, which are made from Siberian iron, and are sent from the Oboukoff steelworks.

M. Schoubersky exhibits, in the park, a model on a large scale, showing the working of the Makhovoz system of locomotion on steep inclines from mines. The apparatus consists of a truck fitted with a pair of 15-ton fly wheels on an axle carried on friction rollers, which themselves rest on the wheels of the truck. Each train of loaded waggons has one of these trucks attached, and is impelled down the incline by its own weight, and the truck wheels in revolving transmit a rotatory motion to the fly wheels by means of the friction rollers. On reaching the bottom of the descent the rollers are lifted by means of levers clear of the truck wheels, and then revolve freely, opposing hardly any resistance to the action of the fly wheels. The truck is

then detached, turned round on a turn-table, and attached to the head of a train of empty waggons. The friction rollers are then let down on to the truck wheels, transmitting to them the rotatory power stored up in the fly wheels, which M. Schoubersky considers sufficient to take the empty waggons to the top of the incline. It does not appear, however, to be a very safe or certain mode of locomotion, and it would be necessary to have in reserve some extraneous assistance in the event of its coming to a standstill, from any cause, before reaching the summit.

Italy.

The Italian exhibition in this class is not very important, the principal objects being some grease boxes, by Benech-Rochetti, and a covered goods waggon and some small locomotive fittings from the Roman Railway Company.

United States. Locomotive.

In the United States section, which is placed in an annexe in the park, the principal object is a locomotive and tender, built by Grant, of Patterson, New Jersey. This, from the peculiarity of its construction and the florid style of its ornamentation, is a complete contrast to the other engines exhibited, and is very interesting as being a type of those used on the other side of the Atlantic. It has eight wheels, the four leading ones being on a bogie, and being made of hollow cast iron with hollow spokes. The four hind wheels are coupled and have compensating levers to the springs. The cylinders are outside, and the slide valves work on anti-friction rollers running on tempered steel plates. The frame is made very light, in order to give it elasticity to meet the inequalities of the road, which is not generally constructed in America in the level and solid manner which is customary in Europe. The weight is also distributed with a view to the imperfection of the roadway, there being only $7\frac{1}{2}$ tons on the bogie wheels and 20 tons on the four coupled wheels. In front of the bogie frame is placed the cow-catcher, a sloping grating made so as to throw off any obstruction to one or the other side of the road. Above this, and in front of the top of the smoke-box, is placed an enormous lamp, or "head-light," with powerful parabolic silvered reflectors, the object of which is not to give warning of the approach of the train, but to enable the engine-driver to descry at a distance any obstruction there may be on the line of rails—a precaution which is very necessary on the unfenced railways in America. A large bell is suspended on top of the boiler, with a cord carried back within reach of the engine-driver. The foot plate is covered by a very handsome "cab," made of inlaid wood and comfortably fitted up. The handles of the

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various cocks are made of ivory, and the covering of the boiler, cylinders, and chimney are of polished brass and German silver. No doubt much of this extra ornamentation is due to the fact of the engine being intended for the Exhibition; but it is stated by Mr. Grant that the American engine-drivers require a greater amount of outward show in their engines than is thought necessary in this country. Above the fire-door are fixed a clock and four cocks for lubricating the cylinders, two of them admitting the oil into the lubricators, and the other two admitting jets of steam, which drive the oil to the cylinders. The fire-bars are hollow and form part of the heating surface, and are said to wear well with the American coal. The tender weighs 9 tons when empty and 18 tons when loaded, and has eight wheels on two bogie frames. The brake is on the wheels of the hinder bogie.

Great Britain.

In the English section, although in individual cases the "exhibits" are unsurpassed, if not unequalled, the Exhibition, as a whole, does not come up to the standard of what might have been expected, either in numbers or in importance of the objects exhibited. In it there are neither goods engines, railway carriages, vans, nor goods trucks; nor, with the exception of some steel springs, are there any specimens of the various locomotive and carriage fittings which are exhibited in such numbers by other nations. None of the English railway companies have followed the example set them by those on the Continent in contributing to the display made by their respective countries.

Locomotives.

Stephenson & Co. exhibit a beautifully finished six-wheeled express passenger engine, built for the Pacha of Egypt. It has inside cylinders, single driving wheels, and a straight double frame. The boiler casing is removed on one side, to show the construction of the boiler, which is made of wrought-iron, the longitudinal joints being welded so as to form complete rings. The plates are thickened at the transverse butt joints to allow for the loss of strength in the rivet holes, and they are double riveted, with outside covering strips. The reversing gear is worked by a screw and also by a hand lever, through an opening in which the screw passes. The hand lever has a sliding catch which can be let down into the thread of the screw, thereby putting the latter into gear. The screw has a curved tapering form, the upper surface following the arc of a circle having its centre at the fulcrum of the lever. For excellence of workmanship, simplicity of design, and chasteness of finish it stands unrivalled in the Exhibition. The principal di-

mensions are: Area of fire-grate, 14 square feet; number of tubes, 161; length of tubes, 11 ft. 4 in.; diameter of tubes, 2 in.; total heating surface, 1,038 square feet; diameter of cylinders, 16 in.; stroke, 22 in.; wheel base, 15 ft. 8 in.; diameter of driving-wheels, 6 ft. 6 in.; weight when loaded, 30 tons, of which 13½ tons are on the driving-wheels, but can be varied, if necessary, by adjusting screws to the springs; weight when empty, 27 tons.

Next to this is a six-wheeled locomotive, by Kitson and Co., for mixed traffic, the workmanship and design of which are also excellent. The four hind wheels are coupled, and are 5 ft. 6 in. in diameter. The cylinders and bearings of coupled wheels are inside, the leading wheels having outside bearings. The boiler is constructed in the same manner as that of Stephenson's engine. The coupling and piston rods and the tires are of steel. The sand-box is worked from the foot-plate by means of a treadle.

The Lilleshall Company also exhibit a very creditable express engine, and as it is one of the first produced in the works of this company, it gives good promise for the future.

Messrs. Ruston and Proctor and Messrs. Hughes and Co. exhibit each a contractor's tank engine. The former firm have adopted Clark's smoke-consuming apparatus, and have fitted the injector directly on to the barrel of the boiler, and have largely introduced steel in the motion works.

Mr. Fairlie exhibits a model and drawing of his system of tank engine. It is a species of double engine, with a large boiler, a central fire-box, and four cylinders, two of which are placed at each end. The boiler is carried on two bogie frames, to which, by an ingenious system of articulation, a considerable amount of lateral play is permitted. Each bogie frame has four coupled wheels, the centres of which are close together, so as to admit of running round sharp curves. The tubes are so disposed as to give a large heating surface, and are moreover led through the steam chest, in order to dry and superheat the steam. The weight is evenly distributed on the eight wheels, and the engine can run equally well in either direction. In general appearance it is somewhat similar to that exhibited by M. Thouvenot, in the French section, under the number 13.

Signals.

Messrs. Saxby and Farmer exhibit a very complete and well-executed working model of their system of locking points and signals, so as to prevent conflicting signals

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being given, and to prevent the possibility of an accident at a junction if the signals be obeyed. The model in question is that of a double junction, with a through crossing on the main line in front of the meeting points. The levers for the main and distant signals and for the points themselves are brought together in a raised signal-box on one side of the railway. A similar arrangement is employed at the Cannon Street and Charing Cross stations in London, where an enormous number of point and signal levers are concentrated into a very small space.

Pooley and Son exhibit a railway weigh-bridge, which has the advantage of admitting repairs and adjustments to be effected without disturbing the road. To secure this the levers are built into the masonry at the sides of the pit, with access from the top by means of a moveable iron plate. The necessity of introducing a relieving or locking apparatus is dispensed with by hanging the bridge on to the projecting arms above the knife edges by means of chain links, which take the oscillation and prevent any lateral motion in the knife-edges.

Turton and Sons and Spencer and Sons exhibit some excellent specimens of steel railway springs.

Mr. Preece shows some models of electric repeating signals, by which the signal given is repeated back to the operator, thus preventing mistakes. This system is not entirely new; but has been modified and improved by Mr. Preece.

Miss Gordon exhibits an ingenious system of electric communication between passengers and guards. The commutator is connected with handles in the compartments, and on pulling them a disc signal is displayed from the side of the carriage, and a bell is rung in the guard's van. The electric coupling between the carriages is very simple and easily managed. It consists of two wooden frames, in which are placed a set of curved metal springs, projecting slightly above the surface of the frames. These springs are connected with the conducting wires of the carriages. The frames have also a catch spring at each end. The connexion is effected in an instant by sliding one frame over the other, when the curved springs are brought into contact with each other, and are then kept in position by the catch springs.

A good system of locking the levers of signals and points is exhibited by Messrs. Livesey and Edwards. It consists of a series of iron rings at the end of bell-crank levers, so arranged that, on pulling over the lever of one signal,

these rings come down over the handles of all the other levers by which conflicting signals might be given, and not only prevent their being moved, but show unmistakeably to the signalman that they are locked, so that the straining of the working parts by futile attempts to work them is avoided.

Mr. Deering exhibits some spring clips for the joints of rails and spring keys, and trenails for railway chairs. They are made of tempered steel, and are hollow, having a slit down their entire length, which admits of compression in driving them, while their tendency to expand again keeps them in their places.

Travelling po

The Post Office authorities exhibit an excellent working model showing the system adopted in England for depositing and taking up the mail bags at stations where the mail trains do not stop. The apparatus at the stations consists of one or more delivering cranes and receiving nets. The former are upright posts with a projecting arm, at the end of which is a catch for holding the mail bags, which are retained in position by springs, adjusted so as to open at a pressure of 20 lbs. The latter are strong nets with an elastic rope apparatus across the mouth of them, for detaching the bags from the train, and are placed at a short distance from the stations, to prevent the risk of accident to persons on the platforms.

The travelling post-office train consists of three carriages, with a continuous communication throughout. Two of them are used for sorting the London and country correspondence respectively, the third being devoted to the delivery and reception of the mail bags. All projections in the interior, which are as few as possible, are covered with stuffed cushions, in order to lessen the effect of a collision on the officials. The receiving apparatus consists of a strong net placed in front of a window at the side of the carriage, and when not in use it is folded up flat against the side, where it is secured by a self-acting catch. The mail bags, after being caught up by the nets from the station cranes, are taken into the carriage through the window. The delivering apparatus consists of two projecting arms at the sides of the carriage door, with spring attachments at the outer extremities, for holding the mail bags. Those arms are hinged at the base, and have a counterpoise attached, which works in a covered sheath, and by which they are drawn up against the side of the carriage on being relieved of the weight of the mail bags. Should it be necessary to deliver more than one bag the second arm is used. This

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is secured out of the way at other times by a catch, which is not released until the first bag has been delivered. The French postal authorities attempted some time since to carry out part of this plan, but from imperfection in their machinery accidents arose, which induced them to abandon it. They have now, however, taken the subject into consideration again, from observing the success of the system in England.

CANADA.

From Canada the principal object exhibited is the model of a sleeping carriage, showing the mode of arranging the berths.

## Report on Telegraph Apparatus and Processes. — (Class 64). — By Robert Sabine, Telegraph Engineer.



The telegraph apparatus shown in the Paris Exhibition contains few novelties, but indicates satisfactorily the quiet progress made in the practical applications of this art-science in the five years which have elapsed since the last London Exhibition. Were it not for such exhibitions as these, the task of tracing the advancements made in telegraphy within certain periods would be an almost impossible one.

Progress in application.

In 1851, Wheatstone's single needle instruments were used, almost exclusively, on the English lines, Morse's electro-magnetic recorders upon the American and Swiss, Bréguet's dial telegraph upon the French railway, and Froment-Chappé's double pointer upon the French state lines. The great telegraph novelty in 1851 was the copying system, of which specimens were shown by both Bain and Bakewell. The public attention was attracted to them in admiration of their performances whilst experience had not yet shown their impracticability. After the Exhibition the ideas of telegraph engineers became more generalised, and we find the fruits of this in the Paris Exhibition, four years afterwards, where the Morse apparatus was shown in a state of transition from the form in which it left the hands of its inventor towards the high degree of perfection it has subsequently reached. In 1862, honours were divided between the Morse and the dial telegraphs. The Morse, adopted almost by all the administrations of Europe, had offered inducements to the manufacturers to devote their energies to its perfection, such as we see it to-day from the workshops of Siemens and Digney. The dial telegraphs had received an impulse from the growing employment of private lines in the metropolis under the energetic influence of Professor Wheatstone.

In the Paris Exhibition of 1867 there is a significant inclination on the part of the French inventors to bring forward type-printing telegraphs. This is the result of the great success attained by Mr. David Hughes's telegraph—the only instrument of similar importance which has not figured in previous exhibitions. It was introduced from America about ten years ago, and promises ere long to rival the Morse in the extent of its employment.

As the principles of this science become more widely known, the applications of it to the wants of every-day life become

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more extended; and as other allied sciences progress they develop new facts which give rise to new suggestions of the means of advancing towards perfect and reliable systems. In this way we arrive, one by one, at the possession of higher standards of merit. Telegraphy is growing, from stage to stage, more practical, because those inventions which do not come up to established standards find their level sooner than they did before these standards existed. Thus the single needle telegraphs, which during long years held their own in England, have almost entirely died out. The infinite host of fantastical schemes of submarine cables and methods which we heard of in 1862 have been frightened out of existence by the great reality of the Atlantic cables; and with such a standard as the Hughes type-printer the numerous inferior schemes which emulation has called or recalled into being in this Exhibition will, infallibly, in a short time retire into oblivion.

Classification in groups.

The writer proposes to classify the subject-matter of the following report in sections, each containing a special group of materials or apparatus, and not according to the order in which they appear in the catalogues. A similar classification was adopted in the jury report on electrical instruments in the London Universal Exhibition, 1862, and was found to have the advantage of facilitating comparison and reference.

## Construction of Telegraph Lines.

### *Submarine Telegraphs.*

Submarine telegraphs.

The submarine telegraph is not so well represented in the Paris Exhibition as the brilliant success which this branch of art has achieved within the past year would have led us to hope. It is sincerely to be regretted that the public, in this Exhibition, have been denied the gratification and advantages of learning the methods and seeing the apparatus employed in making, laying, and testing the Atlantic cables. The engineers engaged in this scheme have not only laid the Atlantic cables, but have at the same time established the future fortunes of submarine telegraphy, which is, perhaps, of still greater importance. In exhibiting their remarkably beautiful appliances they might not have found, it is true, any direct pecuniary profit to themselves, but they would have had the satisfaction of knowing that they were enlightening thousands of inquiring minds on a subject of universal interest.

Atlantic

Regarding the Atlantic cables as the last and great standards for submarine work, although not forming a con-

spicuous part of the Paris Exhibition, it will not be out of place here to give some particulars in connexion with them.

The proportions between conductor and insulator, as well as exterior protection and other particulars connected with these cables, were referred to a scientific committee appointed by the Atlantic Telegraph Company. This committee, taking as the basis of their operations the evidence of several competent persons given before them whilst acting conjointly with a committee appointed by the Lords of the Committee of Privy Council for trade to inquire into the construction of submarine telegraphs, decided upon the details according to which the Atlantic cables should be constructed. The brilliant success which has followed proves the wisdom of this policy above the method previously adopted of referring the questions of construction, &c. to some private engineering firm, whose opinions, although given in good faith, might nevertheless be faulty from imperfect knowledge or warped, perhaps unintentionally, by business interests.

A specimen of these cables is shown in the English section of the Paris Exhibition by Messrs. Webster and Horsfall, of Birmingham, the manufacturers of the iron wires used to give longitudinal strength to the cables. These cables are constructed after the type of that which was laid in 1860 between Toulon and Algiers. The core which was made by the Wharf Road Gutta-percha Company, consists of seven No. 18 gauge copper wires, twisted into a spiral strand weighing 300 lbs. per knot, covered with four coats of gutta-percha, with intermediate compound, weighing 400 lbs. per knot. This core was manufactured in separate lengths of one knot, which were all tested before they left the factory, both under atmospheric pressure and under a pressure of 600 lbs. per square inch, at a temperature of 24° Cels. The sheathing was done at the Telegraph Construction and Maintenance Company's works at East Greenwich. It consisted, first, in a covering of hemp saturated in salt-water, immediately upon the gutta-percha; secondly, in an outer covering for the deep sea portion, formed by ten (No. 13, B.W.G.) wires drawn from Messrs. Webster and Horsfall's homogeneous iron, each surrounded by five yarns of manilla hemp laid on spirally with a preservative compound. The total diameter of the cable is 1·127 inch; its weight in air 36 cwt. per knot, and its breaking strain eight tons.

The particulars connected with the attempted submersion of the first cable in 1865, the successful laying of the second, and memorable recovery, reparation, and completion

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of the first in 1866, are too well known to need more than alluding to here. But the recovery of the 1865 cable was the crowning victory of submarine telegraphy, and from that date henceforth deep-sea cables may be regarded as certain of success. The confidence of capitalists, shaken by the earlier failures of the old Atlantic, Red Sea, and Indian lines, is re-established, and the only question which can arise regarding the undertaking of future deep-sea lines will be their probable employment, and therefore commercial value.

The subsequent faults which have occurred and been repaired sufficiently illustrate the value of laying duplicate cables, as was done between Valentia and Newfoundland. When one cable breaks down the other is used until it is repaired, and thus the service is in no danger of being interrupted.

That which has also very materially enhanced the commercial value of the Atlantic cables is the high speed attained in telegraphing through them, with the improved methods employed, resulting from the increased familiarity which telegraph engineers are beginning to have with the behaviour, under varied conditions, of the strange force we call electricity. Calculated from the data afforded by the measurements of the Red Sea and Malta-Alexandria cables, the speed of working through the new Atlantic did not promise to be higher than 1·15 words per minute.* On their establishment, however, a new system of transmission was adopted, the joint invention of Professor William Thomson and Mr. Varley. The transmission was effected by means of a key of peculiar construction, which for each signal sent a series of five separate waves of different lengths, and alternately positive and negative, into the cable. The first one, which was positive, was the only one intended to reach the further end of the cable and move the receiving instrument. The second wave was negative, of shorter duration, and was wholly absorbed before it reached the further end. The third wave, of still shorter duration, positive, reached only a little beyond half the length; the fourth, negative, still shorter; and the fifth, positive, the shortest of all, attained but a short distance along the conductor. Thus, instead of leaving the cable charged, according to the old method, with one kind of electricity throughout its entire length after every signal, by this method the unabsorbed charge is distributed in five alternately positive and negative sections from one end to the other the instant after the re-

* The Electric Telegraph, 1867, p. 422.

ception of a signal. But this is a condition the most favourable for a speedy equation and neutralization of the whole charge; so that after each signal the cable may be regarded, in a practical sense, as electrically without charge. With this system, and the employment of a modification of Professor Thomson's reflecting galvanometer as receiving instrument, the rate of signalling was increased to five words per minute, or four times as high as that which would have been attainable with the method and with the instruments used on the Red Sea and Malta-Alexandria lines.

Subsequently this system has been replaced by a still more efficient one, suggested also by Mr. Varley.* The conductor at each end of the cable is connected with one of the sides of a condenser of about 40,000 square feet surface, and also, through a great resistance, with the earth. At one end the opposite plates of the condenser are connected with a manipulating key and battery of 10 galvanic elements, by which it may at pleasure be charged. At the other end the opposite plates of the condenser are connected through a Thomson's galvanometer with earth. Suppose a positive signal is to be given at one end, therefore, the condenser plates which are next to the apparatus are charged by the copper pole of the battery being put into connexion with them through the key. The plates to which the cable end is connected receive thereupon, by induction, a corresponding negative charge from the interior of the cable, the neutral electricities of which are decomposed, and a positive charge equal to nearly the fiftieth part of that communicated to the transmitting condenser flows on to the first plates of the condenser at the further end. The opposite plates receive thereupon, by induction, a negative charge from the earth through the galvanometer, the needle of which is deflected. When the signal is given the manipulating key, which remains depressed about one-fifth of a second at the sending station, is let go; and the first plate of the condenser being thus put again to earth, the charge of the second plate is released, falls back into the cable, and neutralizes the polarization produced there and in the distant condenser. In this neutralization the earth connexions of the cable ends, although having a very considerable resistance, play an important part. Suitable commutators at each of the stations enable the receiving and transmitting portions of the apparatus to be easily exchanged for one another, according to the direction in which the signals are to be sent.

With this apparatus a speed of transmission of eight words

* Du Moncel's report; "Etudes sur l'Exposition, etc." vol. i. p. 389.

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per minute is easily attained through the whole length of the cable between Valencia and St. John's.

Insulating materials.

Since 1862 there has been no new insulator suggested for submarine cables. Gutta-percha still holds the foremost place, and since its manufacture has been brought to such a high degree of perfection, it has become, in this position, unexceptionable. A more reduced price would be desirable, but not if this is to be attained at the expense of the purity of the material. Gutta-percha is applied to insulated wires in a series of two or more coatings with intermediate layers of Chatterton's compound—a mixture of tar, resin, and gutta-percha. The application of this compound has the twofold object of filling up any cavities or air holes which might be left in the gutta-percha, and of forming a cement between the separate coatings. It is questionable, however, whether this compound is beneficial to the constancy of the gutta-percha, which has a tendency to absorb the tar out of it, and to leave the resin in a dry state.

Rattier & Co., Bezons, gutta-percha.

The principal exhibitors of gutta-percha wires are Messrs. Rattier and Co., of Bezons, near Paris. The gutta-percha core made by them is of excellent quality. That employed by the French administration of telegraphs contains, per knot, 22 kilogrammes of copper and 33 kilogrammes of gutta-percha, in two coats, with intermediate compound. The writer was allowed to test the electrical conditions of some lengths of this core which were awaiting approval by the Government electrician. The resistances were extremely uniform, and in no case was the insulation less than 700 millions-units per knot, in water at 14 deg. cent. The wire resistances were also such as to show that the French manufacturers are in a position to procure copper of high conducting power.

In the department of the French colonies some wire is shown covered with a gum called "balata," brought from the French African settlement of Senegal. This gum, which resembles in general appearance the ordinary gutta-percha, is less applicable for the insulation of telegraph wires, as its melting point is considerably lower, rendering it more easily liable to mechanical injury when exposed to an augmentation of temperature. In such positions cables insulated with vulcanized india-rubber have been found to behave well.

W. Hooper, London; india-rubber.

William Hooper, London, exhibits a case containing various specimens of his vulcanised india-rubber cables. Mr. Hooper's process consists in the consolidation of a coating of pure underneath a coating of vulcanised india-rubber. He attains this by covering the conductor first with two coatings of pure rubber, then with a coating of some substance called

a separator, and lastly with vulcanised india-rubber. The duty of the separator is to prevent the sulphur of the outer coating penetrating into the interior. The whole is then submitted to a temperature of from 135 deg. to 140 deg. cent., by which the rubber is reduced into a compact coating.

The lengths of cable which have been made by this process have behaved, so far, very well. Their insulation resistances are great; a result, however, ascribable not so much to Mr. Hooper's peculiar process as to the repeated coatings, laid one upon the other, which compose his cables, and to the specific resistance of the material itself; any other manufacturer using the same thickness of rubber would obtain the same insulation. But the advance made by the method in question is in the favourable conditions under which the dielectric is applied to ensure its durability.

To the practical telegraphist so high a degree of insulation is not necessary. To the electrician, however, it is a great boon, enabling him, when the insulation of the whole wire is uniform, to determine the place of a very minute fault with great accuracy and ease, as he can neglect, in his calculations, the shunt resistances due to the leakage between the fault and the ends.

The physical properties of india-rubber are such that it may be heated to a higher degree than is possible with gutta-percha without materially altering either its molecular or electrical conditions. This in in favour of its employment in cables liable to be exposed to heat in transport or otherwise. The self-heating by oxydation of the iron covering, for instance, which was found in 1860 to have injured the core of a length of the Malta-Alexandria cable during the time it was stowed in the tank at Greenwich, would have been without any detrimental effect had the cable been insulated with india-rubber. In stowage in dry tanks during transport cables frequently become spoiled, as was the case with four of the five experimental lengths sent by the Government for submersion in the Persian Gulf in 1863. In such a position the cable proposed by Mr. Hooper would, no doubt, be found to be of great practical value.

Until Mr. Hooper introduced his peculiar process of insulation by pure and protection by vulcanised india-rubber the difficulty of applying the material in such a way as to avoid a chemical action setting in with the copper, had been the greatest drawback to its employment. This difficulty has now been got over, and it remains for time to show if india-rubber, which in air is not more durable than gutta-percha, behaves equally well under water. If so, this material may have an important future in submarine work.

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In gathering data for the establishment of the merits of his system, Mr. Hooper has made a series of quantitative measurements of the electrical conditions of a compound india-rubber covering under different degrees of heat. Thus, a coil of 3,394 yards was tested at different temperatures, between 14 deg. and 100 deg. cent., at intervals of 5 to 6 deg. The result of the series is the establishment of a constant for calculating the effects of temperature on the insulation of india-rubber. This constant is found to be equal to an increase of the conducting power of the 0·1034 part for every 1·66 deg. cent. (= 3 Fahr.)

Mr. Hooper does not exhibit the apparatus which he proposes to use for making joints, nor does he state whether it would be applicable at sea, where it is sometimes necessary to make a joint between deep-sea and shallow-sea ends in a small boat.

Sheathing of cables.

Three different types of sheathing have been employed for the protection of deep-sea cables. The first of these is that of the Dover-Calais cable, in which the insulated core was first spun round with hemp, and over this with a close armature of ten No. 1 iron wires laid on spirally. This cable, laid in 1851 and still at work, was the first iron-covered cable made. It has been taken as the type for many deep-sea lines, and for almost all the shallow-sea cables which have been laid down subsequently. The second type is that of the Toulon-Algiers cable, laid in 1860, in which the specific gravity was first diminished by spinning hemp round each of the wires used in the sheathing. The core was first covered with hemp and then with ten No. 14 steel wires, each separately served. This is the type adopted with success by the scientific committee for the Atlantic cables. The third type is that in which the hemp serving of the core is covered by a tape, plaiting of hemp, or laminous sheathing of copper or zinc. This form was tried for the Oran-Carthagena in 1863, and the Bona-Bizerta in 1864.

Protection from oxydation.

Could sufficient strength be given to a cable constructed upon this type, a material advantage would be found in the freedom it would have from rapid oxydation of the outer covering. To remedy this drawback in iron-covered cables, Messrs. Bright and Clark proposed a method of external protection by means of a bituminous compound, which they adopted in the Persian Gulf cable, laid in 1863. The cable, strengthened in the usual way with an armature of stout iron wires, was served, on the exterior of this, with two coatings of Russia hemp, and then passed through a melted mixture of pitch, tar, and silica, forming upon it a coating impervious to water. Messrs. Siemens have attempted to preserve the

iron wires by converting them into the negative pole of a galvanic element, the positive pole of which is gradually destroyed. They have done this by covering up the iron armature in hemp, and this in an outer laminous sheathing of zinc. An electrical action is set up between the two metals, the zinc being dissolved and the iron left unaffected as long as any of the zinc pole lasts. The idea is very ingenious, it was first suggested about 30 years ago by Dr. Davy for the preservation of iron buoys in sea-water, and has very recently been advocated as a method of sheathing iron ships, but has not yet been employed to any extent.

W. T. Henley, North Woolwich, shows a case of cable samples with sections. In addition to the cables shown in the London Exhibition of 1862, we have the following:—

| Cables. | Laid. | Conductors. | Length in Miles. | Weight in Tons. |
|---|---|---|---|---|
| Denmark - - - | 1863 | 4 | 12 | 134 |
| Norway - - - | 1863–6 | 1 | 50 | 177 |
| Persian Gulf - - | 1863–6 | 1 | 1,615 | 690 |
| Ramsgate - - - | 1864 | 6 | 23 | 207 |
| Italy and Turkey - - | 1864 | 1 | 61 | 186 |
| England and Ireland - | 1865 | 7 | 26½ | 307 |
| Prussia and Sweden - | 1865 | 3 | 55 | 405 |
| Wrexford - - - | 1865 | 4 | 17½ | 321 |
| River Plate - - | 1866 | 3 | 30 | 473 |
| Cooke's Strait - - | 1866 | 3 | 53 | 440 |
| Behring Sea - - | 1866 | 1 | 601 | 784 |
| Norway - - - | 1866 | 1 | 7 | 10 |
| England and Hanover - | 1866 | 4 | 240 | 2,465 |

Siemens Brothers, London, also show a case of cable samples, amongst which are lengths of heavy as well as of light cables. A fine shallow-sea cable is shown by these manufacturers, made by them for the Egyptian Government. It consists of six separate conductors, each of one copper wire, 1·6 mm. diameter, covered to 5·5 mm. with gutta-percha, the whole being protected with tarred hemp and 16 galvanised iron wires, each 5 mm. diameter. For war purposes Messrs. Siemens show a cable of which considerable lengths were made for the Austrian Government during the late war with Prussia. It consists of a single conductor, a strand of three steel wires, 0·75 mm. diameter, covered with gutta-percha to 3·5 mm., and protected with hemp and copper sheathing. As a further protection, sometimes the exterior of this cable is taped, and painted with white lead.

Rattier and Co., Bezons, show various specimens of submarine cables insulated with gutta-percha and protected by hemp and iron wires. The first cable made by

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Messrs. Rattier for submarine purposes was that laid in 1859 for the semaphore telegraph on the coast of Brittany, and which is still at work. Messrs. Rattier likewise show specimens of the cables, with one and two conductors, made for the colony of Senegal in 1861, and for Cochin-China in 1860 and 1864.

New method of submersion.

S. E. Morse, New York, exhibits a model to illustrate a new method of laying and picking up submarine cables. Mr. Morse is a brother of the celebrated inventor of the recording apparatus which bears his name. In order to overcome the inconvenience of not being able to raise a deep-sea cable to the surface at any point, Mr. Morse proposes to provide special points of slack, which can be raised to the surface and underrun. The way in which he proposes to do this is by laying the cable to a certain distance, where a second ship supports it, whilst the cable ship continues the paying out. When the ship is clear away, and the cable considered to be well down upon the ground on each side, the second ship is to proceed in a straight line, at right angles to the direction of the line, easing it down gradually at the end of a rope or chain, to which a buoy is afterwards to be attached. The buoy is intended to facilitate the refinding of the cable if it should be wanted. The writer thinks that Mr. Morse has scarcely been well advised in selecting a buoy for the purpose in question, because it would, in all probability, be hauled up on board some passing ship, and thus not only the trace lost, but possibly also the cable, if it were a light one. The buoy might, it is true, be held by the chain at a distance underneath the surface, and be dragged for by a line between two ships; but the writer doubts if Mr. Morse will succeed in finding a chain sufficiently durable to anchor a buoy in a depth of a couple of miles or so in mid-ocean. To lay a cable in this way would cost a great deal of extra line; but it would at least leave slack—a most essential point for the successful laying—and would increase the chances of being able to haul the cable on board without breaking it.

### *Underground Telegraphs.*

Underground telegraphs.

Referring to the jury report of the London Exhibition, 1862, we see that, whilst other systems were strongly represented, one for underground telegraph lines only was shown. In this Exhibition, five years afterwards, there are six exhibitors of underground lines, plainly indicating the increased attention which is being devoted to this branch of telegraphy, and therefore a growing necessity for it.

The telegraph posts on all the great telegraph highways, as well as in the metropolis, are becoming overcrowded. To

erect new wires endangers them ; to erect new posts beside the old ones would be still more offensive to the eye than at present. The evils of this system are made evident during every storm. It was not long ago, indeed, that nearly one-third of the whole French overhead system was destroyed, and that of England suffered very materially. Were we in possession of an efficient method of underground telegraphy such accidents could not occur; and indeed we may, before long see line after line disappear in tubes, in cables, in sewers, anyhow that is safe, underneath the surface.

Underground lines, almost abandoned in 1862, have since that date been creeping gradually again into favour. The reason is that the difficulties which formerly barred the progress of this branch of telegraphy have one by one been materially lessened, whilst the inconveniences of the overhead system have become more apparent.

The principal difficulties that underground lines have had to contend with have been the carelessness with which the wires were laid and the decay of the insulating materials. These difficulties have been met more completely in France than elsewhere. The prejudice which the French have against wires crossing their streets in all sorts of inelegant angles has necessitated the employment of the underground system in their towns, and the result has clearly shown that when sufficient care is taken in burying the wires and in ensuring perfect cables before they are buried, their electric conditions will last unimpaired for years. The underground cables in Paris are composed of seven cores of copper wire, insulated with gutta-percha. They are placed in the sewers, in the catacombs, and in iron tubes under the streets. The cables which are carried through the sewers are inclosed in lead tubes to prevent the gases developed there destroying the gutta-percha. In the catacombs, which are free from any development of gas, the seven insulated wires are simply wrapped with a tape serving, prepared with sulphate of copper. Eight such cables, supported in a zinc trough, 100 mm. deep and 50 mm. wide, are led along these dark passages. The temperature of the catacombs seldom varies from 12 deg. cent. ; the atmosphere is damp, the floor being generally only a few feet above the level of the wells, and water percolating always through the rock. These are the best conditions possible for the preservation of gutta-percha covered wires in air. For the lines underneath the streets iron tubes are employed to protect them against mechanical injury, whilst they also prevent the circulation of air and retard the deterioration of the gutta-percha by oxydation. The tubes are like those used for gas, of cast iron, in lengths

French system successful.

of 2·3 metres, the diameters being proportioned to the number of wires in them. They are planted in a trench one metre deep. The separate lengths are connected up with lead joints, and at distances of from 50 metres to 150 metres a tube is inserted of larger diameter, which slides over the ends of the two neighbouring ones, so that by pushing it back the lines can at any time be got at. These places are also used for drawing the cables through. This is done in lengths of 400 metres, the cables being well covered with powdered talc to reduce the friction against the sides of the tubes. Five men are employed to plant the lines, and are said to be able to complete a statute mile per day.

The average cost to the French Government of a line of 63 wires, in nine cables of seven wires each, contained in an iron tube 120 mm. diameter, is as follows:—

| | |
|---|---|
| 1. Cast-iron tubes, including trench, laying down, and covering up - - - - | 8,000f. |
| 2. Nine cables (each seven conductors), at 2,900f. per kilometre - - - - | 26,100f. |
| Total - - - - | 34,100f. |

Taking 63 wires, therefore, per kilometre of wire, 541f., or less than 35*l.* per statute mile.

Rattier and Co., Bezons, exhibit cables of two different kinds for underground work.—1. Gutta-percha covered wires, protected with tape and tarred hemp; 2, cables which, in addition to these, are protected with an outer tube of lead. The cotton-covered cables are employed largely by the French telegraph administration on their lines; the lead-covered are mostly employed by the railway companies for tunnels and crossing stations.

Léon Delperdange, Brussels, exhibits specimens of the tubes used in Belgium for the protection of underground lines. They are of iron, with a slit three-fourths of an inch broad along the upper side for laying in the cables and saving them from the chances of injury by being pulled through. When the cables are placed in the tube a length of ⊥-iron, *b*, *b*, fig. 1, broader at the bottom than the slit, is put into each of the sections and fastened there by means of three iron wedges, *c*, *c*, passing through holes in the upper rib of the ⊥-iron. The

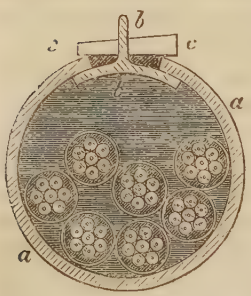


Fig. 1.—SECTION OF BELGIAN TUBE, CONTAINING UNDERGROUND TELEGRAPH LINES.

space above the latter to the height of the top of the tube is then filled in with some water-tight cement, which seals it up completely, but which can at any time be removed with a chisel in order that the cables may be taken out and examined, if necessary. The joint between two separate lengths of tube is made by a ribbed clip, which presses a collar of vulcanised india-rubber over two slightly elevated rings on the neighbouring ends of the tubes. At regular distances the tubes enter round testing boxes, formed by cylindrical chambers covered by flat lids, with packing of india-rubber. MR. SABINE ON TELEGRAPHY.

The expense of gutta-percha covered wires, and their frequent and rapid decay when exposed to the air, have induced repeated experiments to be made to employ asphalte and bituminous compounds for the insulation of underground lines. Until recently these experiments, although sometimes carried out on an extensive scale, have not been attended with success, whether from the unsuitableness of the material employed or from the want of sufficient care and familiarity with the subject, it is difficult to decide. Three different systems of insulation by bituminous compounds are now brought forward:—(1.) that of manufacturing and planting the lines in rigid sections; (2.) that of laying down naked wires in a trench and pouring in melted pitch upon them; and (3.) that of rendering the pitch plastic by which wires covered with it may be coiled. Lines insulated with bitumen.

The most promising of these systems is that of rigid sections invented by Mr. Donald Nicoll, of Oaklands, Kilburn, specimens of which are shown in the British department. The wires are of copper, No. 16, B. W. G., placed parallel half an inch apart in a bituminous compound, and protruding about an inch from each end for the purpose of making the necessary joints between the sections. At one end of each section the wires are twisted in hollow coils or "corkscrews;" at the other they are straight. In planting the lines the straight ends of one section are intended to be pushed into the coils of its neighbour, and good metallic contact secured by pressure or by the blow of a hammer. When the wires are thus connected up, a short tube, which embraces the ends of both sections, is put over them, and the space filled up with melted insulating compound, by which means the insulation of all the wires at the junction is effected at once, requiring little skill or practice on the part of the workmen employed. This is certainly a great point in favour of the proposed system. The wires are first covered with a plaiting of coarse hemp well dried, through the fibres of which the melted bitumen penetrates. In being Nicoll's system.

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made up, the sections are strengthened by the introduction of strips of common cane, and held together by an outer plaiting of jute coated with bitumen. The inventor believes that the transport of these rigid sections with any number of wires insulated by this method, would be a matter of no difficulty whatever, and that the planting, joining up, &c. could be done much more rapidly than the same length of overland line could be erected. In a circular distributed at the Exhibition attention is called to the cheapness of the system, its secrecy and its comparative freedom from injury by ordinary accidents. Lines insulated in this way would unquestionably be entirely free from decay, the wires being hermetically sealed up in an imperishable material. An experimental line laid down some time since for the Royal Engineers at Chatham has been found to have an insulation resistance equivalent to 12 millions of units per knot, and has afforded evidence that these lines when planted are capable of resisting rough usage, such as the passage of artillery or heavy waggons; and also that, laid down along the six-foot way, the vibration of the earth caused by the passage of the trains on the lines would not affect them. The induction between the different wires forming the lines is very inconsiderable, as their distance from each other is sufficiently great; so that there is no reason on this account why the system might not be introduced as part of already existing lines without occasioning any modification whatever in the present apparatus employed.

Holzmann's system.

A. Holzmann, Amsterdam, exhibits a length of line as suggested by him for use in Holland. Instead of planting previously prepared rigid sections, Mr. Holzmann manufactures his line as he lays it down; he first places his cast-iron troughs in a trench; then places the wires in them, dividing them by glass supports, and, lastly, pours in melted gas pitch. The trough is afterwards covered up with a lid, which is wedged on. Half a mile of this line is at work between Amsterdam and Abcoude, and is said to be very satisfactorily insulated. But the method of dividing the wires by glass supports seems objectionable as it would be impossible to prevent the expansion of the wires on pouring in the melted pitch. Fine weather would also be indispensable with this method.

Jalloureau's system.

The third suggestion is that of Mr. Jalloureau, of Paris, who covers his wires with a flexible bituminous compound put on with strips of brown paper wound spirally round, the whole forming a core which may be transported, in any length, upon a drum. The paper is well dried before being used, and is well impregnated with the compound. After

the wire has been coated with the requisite number of laminous spirals and intermediate compound it is wound round helically with two iron binding wires in opposite directions. The purpose of these wires is to invest the core with a superior longitudinal strength than it would have from the paper alone, and at the same time to keep the paper strips from injury. Core made in this way is when new very flexible, and may be coiled when cold round a drum of 6″ radius without sustaining apparently any damage whatever. The writer considers, nevertheless, Mr. Jalloureau's system to be inferior to either of the others, although it aspires to attain more. The attempt to construct a permanently flexible core with an asphalte compound can never be successful, because the material has, naturally, so little cohesion, even when softened by the admixture of tar, or other hydro-carbons, that a sudden jerk is almost always attended with a rupture, and it increases it degree of hardness so materially with a small decrement of temperature, that in coiling or uncoiling the core it would always be in danger of receiving faults in insulation. There is also an objection to the use of tar, that not being procurable in large quantities in a state free from water, its specific insulation is very low, and its admixture with the asphalte would only diminish the insulating capacity of the latter.

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The idea of asphalte insulation is not new; it has been repeatedly tried and has as often disappointed its advocates. Nevertheless it has never been satisfactorily proved that the system is a bad one, but rather that some other element to success was wanting. The best invention without energy and intellect to carry it through will, in the majority of cases, fail. As probably, however, neither of these important elements is wanting now, there are reasonable hopes that, with the benefit of all the experience and failures bequeathed to them by earlier workers in the same field, the promoters of asphalte insulation may succeed in their endeavours to give us cheap underground lines, by which they will be doing a most welcome service to telegraphy.

### *Overhead Telegraphs.*

In the construction of overhead telegraphs there are two principal conditions of success. One is that the line wire may have a high absolute strength in order that it may be fairly strained on long spans without danger of parting, the other is that the points of suspension, or what are called "insulators," may allow as little leakage of the current as possible from the line wire to the earth.

Overhead telegraphs.

MR. SABINE ON TELEGRAPHY.

Line wire.

Since the 1862 Exhibition the manufacture of iron line wire has been considerably improved. The iron is of better quality and it is drawn in longer lengths. Messrs. Menans and Co., Paris, show specimens of French telegraph wire. A coil of 3 mm. diameter, with welded joints, is shown, measuring 1,234 metres and weighing 68 kilog. The breaking strain is 438 kilog., or 62 kilog. per square millimetre section. Amongst the best telegraph wires exhibited are those of Messrs. Johnson and Nephew, of Manchester. The single lengths drawn by these manufacturers exceed those of any others. They measure as follow:—

Gauge No. 3 = 530 yards, weighing 281 lb.
„ „ 8 = 900 „ „ 200 lb.
„ „ 11 = 790 „ „ 95 lb.

Long lengths of line wire without weld or joint are important for overhead lines, reducing the danger of the wire parting, either when stretching the line or in winter, when the wire contracts.

Line insulators.

The original forms of line insulators are now nearly obsolete, the different administrations having adopted for some years various improvements, to which, in most instances, they adhere. Thus in Germany the porcelain bell with deep groove is almost exclusively used for line supports; in France the so-called mushroom insulators are employed, both on Government and railway lines; in Belgium they use a single bell insulator held by a band of iron passing round the top, and the wire being suspended by a hook underneath; in Spain they use an insulator constructed on the same principle, but vastly inferior; in India the excellent iron-capped insulators of Messrs. Siemens are mostly employed; and in America the insulator with paraffin invented by Mr. Brooks.

The line insulators shown in the Paris Exhibition are of three classes: (1) those formed of a single piece of insulating material; (2) those formed of two or more insulating cups cemented together; and (3) those supplied with an outer armature of iron. To the first kind belong the Prussian, the ordinary Spanish, the Belgian, and the French insulators, as well as some of the English systems.

German insulators.

The Prussian Telegraph Direction, Berlin, exhibits two complete lines, with station introductions. The insulators used on the Prussian lines are the porcelain bells of Mr. Latimer Clark, the grooves of which are made somewhat deeper and narrower than he made them in order to render the escape of the current over the surface as difficult as possible. The bells are provided with grooves at the sides and on the tops. The wire passes sometimes by the one

and sometimes by the other. Specimens of these connexions to the insulators are shown, and also of the manner in which thick wires are joined to thin ones. The wires of which these two sample lines are made are of different thicknesses, one being 4 mm. and the other 5·3 mm. diameter. Both are joined to thinner wires before being introduced into the stations. This is done by making a loop with each wire over the insulator from opposite sides and soldering the two ends after twisting them together.

French insulators.

The French Administration of Telegraphs, Paris, exhibits also complete lines insulated and connected in the French style. The insulators are of two kinds—those of which the porcelain is formed in a flange, screwed directly to the post, used as line supports; and those which are held by an iron stalk underneath, used as stretching insulators. The latter are the better of the two, but are not so good as either the German or the English insulators.

Varley's insulators.

Insulators belonging to the second class, those formed of a combination of two or more inverted cups, are shown by Messrs. John Bourne and Son of Derby. They are mostly models of the insulator very extensively used in England, and generally known as Varley's, consisting of an interior and an exterior cup of red glazed earthenware, cemented together and supported upon a pin, the upper end of which is cemented into the central cavity of the smaller bell. The other end of this is tapped and supplied with a nut by which it is fixed to the wooden cross arm of the post. Sometimes, as a means of further insulation, the upper end of the pin is covered with vulcanite. This insulator forms a light, cheap, and efficient support, and the employment of two cups of close glazed earthenware cemented together gives an additional guarantee against bad insulation from faults in the material.

Austrian war insulators.

The line insulator used by the War Department of Austria belongs to this class. It consists of two bells, one glass and the other vulcanized india-rubber. The india-rubber bell has an interior cavity, into which a pin on the top of the portable telegraph post is forced; the glass bell is then drawn on and sits firmly in its place by the compression of the india-rubber. The line wire used for the Austrian military telegraph is of copper. It is fixed to the insulator by simply twisting it round the upper part of the glass bell.

Iron bell insulators.

The stoutest of all the line insulators are those supplied with an exterior armature of iron. The first insulators constructed on this principle were those of Messrs. Siemens and Halske; they have subsequently been modified by Mr. David Brooks of Philadelphia.

Siemens' insulator.

Messrs. Siemens' insulator consists of a cast-iron bell, on one side of which is a flange with three holes, by which it is

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screwed to the post. The bell has a convenient form for the reception of the porcelain cup, which is cemented into the upper cylindrical part. The porcelain cup is also formed in a bell shape, and is ribbed both in and outside for giving a good hold to the cement by which it is fixed into the iron armature and the stalk or carrier into its central orifice. These insulators are very extensively employed in India, Egypt, and other eastern countries where strength and durability are first considerations.

Zapata's insulator.

The Spanish Telegraph Direction, Madrid, exhibits two insulators of peculiar construction attached to what is intended to represent the top of a wooden post. They are the suggestion of Mr. T. M. Zapata. This insulator consists of a taper-shaped porcelain tube, which carries a iron hook in the central hole, and is supported by a wrought-iron collar, allowing the hook to project underneath. The top of the collar is covered by an iron lid. This construction allows the porcelain to be easily changed in case of a fault.

Insulators for living trees.

The Prussian Telegraph Direction has employed an insulator of this class for suspending line wires from living trees, the invention of the Director-General von Chauvin. It is constructed similarly to Messrs. Siemens' insulator, only instead of the flange to secure it to the post it is provided with a long hook by which it is hung up to a bracket fixed to the stem of the tree. The stalk or carrier is also much longer than that in Messrs. Siemens' insulator, and is bent in a curve to keep the wire free from the stem, in case the tree should rock during a storm. In those neighbourhoods where it is possible to employ this system it has been found to have great advantages, as the lines so constructed are of course entirely free from the decay of the wooden posts. But its employment has remained very limited, from the fact that where the most trees are to be found the fewest telegraph lines are required.

Brooks' insulator.

The insulator which has of late years been introduced in great numbers on the American lines is similar in principle to that of Messrs. Siemens. It consists of an outer cylindrical cast-iron armature, in which is cemented an inverted green-glass bottle of such a form as to allow a stalk or carrier of malleable cast-iron to be cemented into its interior. The cement used in making up this insulator is sulphur and shellac, the insulation being improved by the use of paraffin. Mr. Brooks, the constructor of this insulator, professes to depend for superior insulation upon the inner surface of the blown-glass bottle, which he has found to resist a deposit of water and dirt considerably longer than either a glass surface which has touched the form in blowing or an enamelled surface. These insulators have been submitted to

experiments by the *Commission de perfection* appointed by the French telegraph administration, and have given favourable results.

Telegraph posts.

The transition from wood to iron for telegraph posts goes on slowly but surely. Indeed it would be an anomaly if in these days, when iron is being introduced into all works of engineering and architecture to supplant wood, that this perishable material should long be obstinately employed in a position the most favourable for its rapid decay. That wood is cheap and iron dear is no reason at all for employing the one and rejecting the other for telegraph posts. Let an iron post cost four times as much as a wooden one, it lasts ten times as long, and is, therefore, in the long run twice as cheap.

French iron posts.

The French Telegraph Administration shows an iron post which is being introduced on some of their lines as an experiment. It consists of a cast-iron socket standing 3 metres high out of the ground, in the upper part of which is wedged and cemented a length of 2·5 metres of rolled + section iron, tapering from 0·07 metre to 0·05 metre in width, and 0·01 metre thick in the ribs. These posts, notwithstanding their very slight appearance, are found to be capable of resisting a considerable strain. It must, however, be confessed that the same amount of material could be more profitably employed in the form of a tube. The insulators shown with these posts are of the same construction as the insulators of the French lines. The iron brackets which support them are fixed sometimes into the angles between the ribs of the upper post by means of collars, and sometimes they are bolted to the ribs.

Siemens' iron posts.

Messrs. Siemens Brothers, of London, show two specimens of their tubular iron posts and of the insulators used with them. These posts are composed of three parts, an upper conical welded iron tube, a cast-iron socket, and a Mallet's buckled plate forming the base. The cast-iron socket, 2·8 metres high and 0·135 metre diameter, is bolted to the buckled plate which is buried two or three feet in the ground. This socket is cylindrical and forms the pedestal for the graceful conical tube, 3·7 metres high, and tapering from 0·1 metre at the bottom to 0·05 metre at the top, which forms the upper post. The two are fastened together by means of cement. These posts are stronger, and in every way preferable to the French ones. In India, Mesopotamia, and Egypt they are said to have gained a considerable employment. The insulators used with these iron posts are of the construction already described, but two iron bells are sometimes cast upon the ends of a single cross beam, which is supplied with a cylindrical hole in the middle to fit the

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upper part of the conical tube. This cross beam is secured by the pressure of a single screw.

In those countries where wooden posts very quickly decay, as for example in India, iron posts have already been very extensively introduced. Elsewhere iron posts will be introduced, beginning with those countries which have the best insulating supports; but where, as in Austria, the ordinary line supports are inferior both in form and material, and, absurd as the fact may seem, the insulation of the lines depends to no small extent upon the insulating condition of the posts, iron will not so quickly find employment.

## Electro-Telegraphing Apparatus.

### *Needle and Acoustic Instruments.*

Needle and acoustic instruments.

Needle instruments are gradually dying out. The acoustic instruments which have probably the greatest future are those known as American sounders. These, whilst possessing all the advantages of simplicity and cheapness which caused the needle instruments to be so extensively employed, have a practical superiority in being worked by the system of continuous currents.

Professor Gloesener, of Liège, exhibits a single needle instrument of peculiar construction. He employs to produce the deflections of the needle, in addition to the multiplier, two electro-magnets of which the wire helices form continuations of that of the multiplier. Each of the two electro-magnets acts upon a different pole of the needle, whose distance is made great enough to avoid any irregularity in the working of the instrument arising from residuary magnetism. Mr. Gloesener believes that this arrangement, whilst not very materially increasing the total resistance of the apparatus, nearly doubles its force.

Thomson's galvanometer.

Amongst the single needle instruments of novel construction is the reflecting galvanometer of Professor Thomson used to receive signals through the Atlantic cable. This instrument differs in principle from Wheatstone's single needle instrument only in the employment of a small mirror attached to the magnet, which reflects a beam of light upon a white paper scale and thus indicates the direction and amount of the deflection.

The Spanish Telegraph Direction shows a double style recording apparatus constructed by Mr. E. Bonet of Madrid. This apparatus is worked with a key giving double contacts, and is said to be capable of much faster manipulation than the ordinary Morse. Attached to the armature of the electro-magnet is a hammer playing between two bells by means of which the receiving clerk can read by ear.

American sounder.

W. Bond and Sons of Boston exhibit a sounder as used on the railway lines in America. It is contained in an oval box 3 inches long, 2 inches broad, and 1 inch deep, and comprises a transmitting key, switch, two terminals, and electro-magnet with armature and adjusting screws. The system of telegraphing used mostly upon the American lines is that of reading the signals by ear instead of by eye, having the apparatus arranged so that, in repose, the current of a battery is constantly passing through the line, the signals being given by interrupting the circuit in some point. With an arrangement of this kind only a single battery is required in each line circuit, and the apparatus is of the cheapest and most durable construction. On the railway lines this system is found to be of important service in cases of accidents occurring to trains, the guard by cutting the line wire and inserting a simple pocket sounder being able to communicate with the neighbouring stations without the necessity of having a battery.

Messrs. Siemens Brothers, London, exhibit a sounder, with relay, transmitting key, and terminals, intended for use with line and local batteries. The apparatus is contained in a convenient mahogany box 8 inches long, 6 broad, and 3 deep. The relay is of the simple construction with horizontal coils, known as the American relay; the sounder consists of a simple electro-magnet whose armature is carried on the end of a beam playing between two screw points.

Mr. Bréguet shows a sounder of very simple construction. It is formed of a small vertical electro-magnet over whose poles a soft iron armature is held upon a bandspring, which dispenses with the axis, bearings, beam, and adjusting screws. This armature strikes upon an upper and lower anvil, one of which is supported upon a piece of wood hollowed out underneath to serve as a sounding board. This simple arrangement (which is sold at 20 francs complete) is equally adapted for employment with continuous as with occasional currents; but it is, of course, incapable of a fine adjustment. The French Telegraph Administration in their exhibition of apparatus as at present in use in their stations show these sounders as adjuncts to the Morse apparatus, in which position they operate in the place of alarms, and, if the employés are sufficiently accustomed to the apparatus, also as sounders by which they may read the message, preserving the record made by the Morse only for the justification of the direction in case of dispute.

A continued practice with the Morse apparatus leads the employés involuntarily to recognize the signals by ear, and when they have once attained proficiency in this way of

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reading, they seldom, if ever, return to the more inconvenient and fatiguing one of reading by sight.

### Step-by-Step and Railway Instruments.

Letter showing instruments.

The step-by-step pointer telegraph, invented by Professor Wheatstone in 1840, has been modified and improved in various ways to suit the various services in which it has been applied. These modifications and improvements have taken gradually a national character. Thus in France, in the hands of Bréguet, Froment, and Digney, the step-by-step apparatus has been endowed with a form highly perfect but totally different in type from those of Stöhrer, Siemens, and Kramer in Germany. And these again have taken a form totally distinct from that which Wheatstone has given his later apparatus.

In France the railway instruments are, almost without exception, worked with galvanic currents. In Germany and England, on the contrary, magneto-electric currents are almost invariably employed with the step-by-step apparatus.

Both these systems have individual advantages and disadvantages which render it impossible to acknowledge one in the end superior to the other. The system with galvanic currents is convenient, as it enables the operator by augmenting or diminishing his battery power to accommodate his apparatus to the length and conditions of his line; it is inconvenient as it necessitates a continued attention to the battery. The systems with magneto-electric currents are convenient as, being without batteries, they are ready at a moment's notice for work, and require no attention; they have the disadvantages however that their force cannot be augmented to suit an increased length or decreased insulation of the line, and that the magnets gradually lose their power and therefore require renewing.

Each inventor of course looks mildly upon the drawbacks attending the system which he has taken as the basis of his own apparatus. And as the principal inventors are generally the principal authorities, it follows, as a natural consequence, that the systems adopted in different countries are different.

Bréguet's dial telegraph.

Mr. Breguet's railway telegraph is the type of the class using galvanic currents; it has been in constant use on the French railway lines for the last quarter of a century. This apparatus consists of a transmitter, for making and breaking circuit of a battery with the line, and of a receiver with a clockwork. The transmitting contact is worked by a lever, the end of which carries a roller in a sinuous groove underneath a circular plate, turned on the axis of a handle moved over a dial plate. Each current, as well as each interruption, indicates a letter. The receiver consists of a clockwork,

whose escapement is released by the backward and forward motions of the armature of an electro-magnet in the line circuit. When the needle skips it is brought back to zero by pressing a button which puts the pallets out of gear and allows the scape wheel to run round until a pin carried by it catches against a proper stop. This apparatus from its simplicity and cheapness is likely to keep its place as a railway instrument, especially where a record of the despatch is not required.

M. Bréguet also shows a very compact arrangement of the transmitter, receiver, and alarm of this system in a small mahogany box, the suggestion of Mr. Louis J. Crossley, of Halifax. The box is divided into three sections; the top section forming the lid contains the alarm; the second section the receiver; and the lowest section or bottom the transmitter. When the box is closed the alarm is in circuit, but in being opened between the bottom and middle sections to transmit or receive, the alarm is put out of circuit.

Digney, Hipp, Fardley and others also exhibit dial telegraphs worked with galvanic currents; but they differ from that of Bréguet only in a few mechanical details.

Wheatstone's universal telegraph.

As the inventor of this system of telegraphy, although his apparatus in its present form is of more recent date than many of the others exhibited, it is only fair to consider Professor Wheatstone's universal telegraph as the type of the class of dial instruments worked by magneto-electric currents.

Specimens of this apparatus are exhibited by the Secretary of War, London, in the form shown in figure 2.

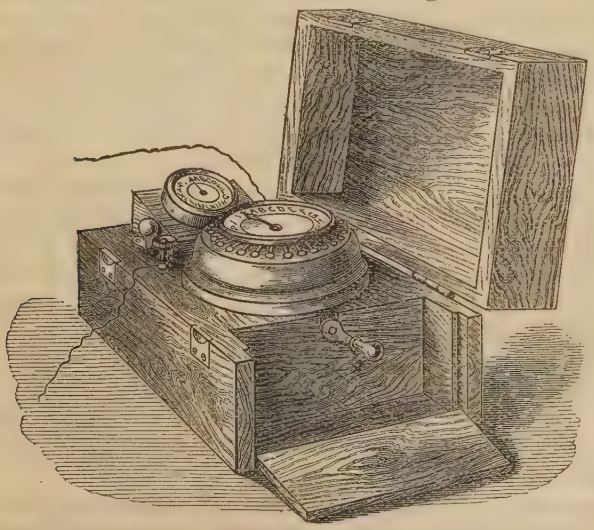

Fig. 2.—WHEATSTONE'S MAGNETO-ELECTRIC DIAL APPARATUS.

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This is the lightest and neatest of all the step-by-step telegraphs. The apparatus is compactly arranged in an oak box for convenience of transport, the lid being fastened by catches so constructed that the fastenings are flush with the face of the box, and not therefore liable to be injured. The dial shown in the fore part of the apparatus surrounded by the keys, together with the handle in front, by turning which the currents are generated, forms the transmitter. The receiver is the smaller dial erected upon an inclined surface at the further end of the box.

This transmitter consists of two bobbins coiled upon an armature and rotated continually over the two poles of a battery of permanent horse-shoe magnets. With the bobbins turns correspondingly a wheel with inclined teeth. When a letter is to be telegraphed a certain number of currents is sent into the line which moves the indicator exactly as far as is required. This is done as follows:—The tooth-wheel is fixed upon a hollow axis, and above it, on a central axis, an arm with a spring, which falls into the teeth of the wheel, a contact disc, and the pointer which denotes upon the dial the last letters telegraphed. The letters are telegraphed by pressing down buttons on the circumference of the transmitter. Each of these buttons depresses a lever inside, against which the rotating arm catches and is arrested, the spring being lifted out of the teeth of the rotating wheel. During the time, however, that the contact disc is rotating, it makes and breaks contact continually in such a way that, at those points where the arm could meet a lever, the line circuit is interrupted. Therefore, when the arm does meet a lever, which prevents the contact disc rotating any further, the lines remains interrupted. When another letter is to be telegraphed, its corresponding button and lever are depressed. By this the lever of the first button is pushed back and the spring on the arm allowed to fall into the teeth of the rotating wheel, by which the arm and contact disc are carried round until the former comes into contact with the last lever. In this way just so many currents of equal strength are sent into the line as there are letters between the two buttons. The levers are all arranged in a circle, vertically, and press a pitch-chain into a series of indentations on the periphery of a metal disc. The chain has slack enough to allow one lever to press it in; but as soon as a second is depressed, not having slack enough for both, the first lever is pushed out again and the arm released.

The receiver of this apparatus has two electro-magnet bobbins, between whose poles two little bent magnets oscillate

and move a small ratchet wheel between two fixed clicks, by which the wheel acquires a rotatory motion. A pointer is fixed upon the same axis, and indicates upon a dial card.

For private telegraphs this apparatus is found to answer every requisite. It may be questioned, however, whether it is not too delicate for military purposes, where strong currents are required to overcome bad insulation, and strong apparatus to resist injury by hurried and rough transport.

Siemens' dial telegraph.

Siemens Brothers, London, exhibit their magneto-electric dial-telegraph as used by the London Fire Brigade. The transmitter consists of a battery of permanent magnets, between whose poles a barrel armature coiled longways with wire is turned half round for each letter to be indicated. The receiver consists of a polarised electro-magnet constructed similarly to the polarised relay of the same manufacturers. The end of the armature forms a fork, the two ends of which are provided with spring pallets, catching the teeth of a small ratchet-wheel, and pulling it a step round whenever the armature is deflected from one pole to the other.

A most useful variety of this apparatus for military purposes is shown by Messrs. Siemens Brothers, having the transmitter and receiver contained in a knapsack which a soldier may conveniently carry on his back. The knapsack has a pocket on each side. In one the transmitting handle is contained, and in the other three wooden legs intended for supporting the apparatus when at work.

In the Prussian section Messrs. Siemens and Halske exhibit two specimens of the same apparatus with the indicator and transmitting dials combined. The indicator is supported upon a metallic pillar in the centre of the transmitter, and the handle, instead of moving over the dial, is bent in a convenient form, allowing it to work into notches on the rim of the transmitter in the annular space between this and the case of the indicator. The driving wheel, turned directly by the handle, sits immediately underneath the indicator, and is guided by the central pillar.

The number of magnets employed in each apparatus is now usually only six, made in the horse-shoe form instead of separate bars screwed to a neutral block. These magnets are secured at distances of about one-eighth of an inch apart, and in a space cut out between these poles the barrel-armature with a long insulated copper wire wound longitudinally is turned half round for every current which is induced. These apparatus are very powerful in the currents generated by them and may be worked with certainty on very long lines, even when the latter have a considerable resistance and are not well insulated.

The peculiar form given to the bobbin allows the full

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force of the magnetic changes to be taken advantage of for the production of the currents in every part of the wire. When magnets are bolted close together so as to make contact, the separate bars tend to depolarise each other, so that the sum of their intensities is considerably diminished; whereas by placing them at a sufficient distance from each other this depolarising action is in so far reduced as to leave each separate horse-shoe very nearly its full and independent intensity. By this means nearly double the current is obtained with a given number of magnets and length of wire than would be from the same material were the magnets laid one upon the other so as to form a single magnet and the wire coiled upon vertical bobbins and rotated over the common pole.

Guillot & Gatget's dial telegraph.

Guillot and Gatget, Paris, exhibit a magneto-electric dial telegraph, the transmitter of which consists of four bobbins with soft-iron cores fixed in the corners of a square upon the two poles of a permanent steel magnet, as in one of Professor Wheatstone's telegraphs. A soft-iron keeper, upon an axis which passes in the middle between the four bobbins, rotates over their poles and alternately closes the magnetic circuits of the opposite ones. The axis of the keeper carries a pinion which engages with a tooth wheel on the arbour of the transmitting handle. The latter turns over an ordinary French dial plate. The wire of the bobbins forms a single circuit, one end of which is to earth and the other connected with a metal spring, which, when the handle is raised to turn it round, makes contact with a ring on the central arbour in permanent connexion with the line. When the handle sinks into one of the notches of the dial plate this ring is depressed, breaking the circuit of of the bobbins and making contact with the receiver. The soft-iron keeper is nearly broad enough to close the circuit of two poles at the same instant that it leaves the circuit of the two neighbouring ones. The purpose of this is, that the currents induced by the armature leaving and approaching may be combined to form a single current. On lines with little resistance this transmitter may work well, but, whilst neither the bobbins nor the magnets are moved, it cannot be expected to give intense currents.

The receiver used with this instrument is almost identical with that of Bréguet's step-by-step railway telegraph; only, to accommodate the reversed currents, the keeper is formed by a permanent magnet which plays between the poles of two electros, one on each side of it.

Marcus' dial telegraph.

The Imperial Telegraph Commission, Vienna, amongst other apparatus for military purposes, shows an electro-magnetic dial instrument constructed by Mr. Marcus, of

Vienna. The transmitter is formed by a Stöhrer's induction apparatus in which two bobbins, upon the ends of a soft-iron armature, are rotated over the poles of a permanent magnet. The receiver consists of an electro-magnet between the poles of which a small permanent magnet oscillates and turns, by means of two pallets fixed upon it, a ratchet wheel on the axis of the pointer.

The dial plate of the transmitter is not supplied with holes or notches in which the handle can be arrested. In consequence of this want, it is almost impossible, when transmitting with a uniform velocity, as is necessary in using magneto-electric apparatus, to arrest the handle exactly at any letter. This is evidently not an oversight, but is done purposely, on account of the weight and form of the rotating bobbins, which, when in motion, acquire a considerable force. Were they to be suddenly arrested by the handle catching against a notch, this force would be converted to the destruction of some part of the apparatus. With this slight drawback, this magneto-electric telegraph has considerable merits, its power being superior to many of the others exhibited.

## Type Printing Telegraphs.

Type printing telegraphs.

All the type printing telegraphs shown in this Exhibition are worked by galvanic currents, none by magneto-electricity. Experiments have repeatedly been made to render the latter serviceable to printing telegraphs; but the limited intensity of the currents induced in wire moving over magnets, and the impossibility of varying it to suit the variations in the conditions of long lines, leaves little hope of its ultimate employment for this purpose.

Printing telegraphs are probably of American origin. One of the first apparatus which Morse brought to perfection was of this nature. After him came Vail and Wheatstone. In this, as in some other branches of telegraphy, however, Morse seems to have given only the first idea, and left it to the energy of others to convert it into a reality. The inventions which have followed since of type printing telegraphs are more numerous than those of any other kind. The reason is that this is one of the prettiest problems in telegraphy, and at the same time not the most difficult. Of these inventions the principal part has long since fallen into disuse. The remainder are either those which possess merits sufficient to recommend them as practical instruments, or those which are new and have not yet had time to become failures.

There are two classes of type printing telegraphs—

1. Those whose type wheels are worked by means of clockwork;
2. Those without clockwork.

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The majority of type printing telegraphs belongs to the first class—those whose receivers are constructed with mechanical driving power. The apparatus at each end is similar, and the movements of the clockworks, with type wheels and contacts, are regulated either by means of synchronously oscillating pendulums or by means of the currents themselves which control the movements of escapements.

Hughes' telegraph.

Mr. Hughes' type printing telegraph is of the class in which the clockwork is regulated by a pendulum. This apparatus, the best of all the type printing telegraphs, differs from others in the printing being done whilst the type wheel is in motion, by which an immense saving in time is effected, and a correspondingly increased amount of work got through. The bold idea of constructing a telegraph apparatus sufficiently strong, and at the same time sufficiently sensible to respond to single currents, to print letters whilst in full rotation, and not lose its synchronism in doing so, occurred to Mr. David Hughes, an American, 18 years ago. Since then he has but very slightly modified his original construction. The principle has remained the same, and only the mechanical details have, in the hands of Froment and Digney, taken more comely forms.*

By printing without slackening speed this apparatus is capable of receiving more letters per minute than any other. It consists of a clockwork, at each of the stations, driven by the descent of equal weights, and made to go nearly synchronously by similar regulators, either vibrating springs or conical pendulums. In this way the two type wheels revolve about 120 times per minute, for all practical purposes, correspondingly; that is to say, at any given moment the same letter will be in the same position on both the type wheels. The printing press is set in motion by a cam turned upon an axis whenever a current passes through the releasing electro-magnet. Each apparatus is supplied with an arrangement by which the operator can send a current through the electro-magnet of both stations at the instant any desired letter on the type wheels is underneath.

This telegraph is complicated, and requires the continued presence of a good mechanician to keep it in order; but, by way of compensation for this drawback, it is not only the most beautifully arranged, but the quickest in its operations and the most economical in its use of the electric current of any yet introduced.

They are found to be invaluable on all lines on which much business is transacted. They are employed to a great

* The writer has given a detailed description of this apparatus in the "Electric Telegraph," p. 55.

extent in France between the principal stations; they are likewise used in Russia, Prussia, Italy, and England on land lines, and in Persia on the line containing the submarine cable between Kurrachee and Bushire.

Desgoffe's telegraph.

The type printing telegraph exhibited at the stall of Messrs. Digney frères—the invention of Mr. Desgoffe—approaches in principle nearest of any to the ideal of a type-printing instrument in which the type wheel is arrested during the printing, because the clockwork is not stopped, and only two currents are required for each letter. But, strangely enough, with all these advantages, the apparatus exhibited works slower than any of the others. This is the only apparatus shown in which the type wheel is automatically adjusted between each letter. It consists of synchronously rotating type wheels, the printing press being set in motion by a current sent from the transmitting station at the instant when any type which it is desired to print is underneath. The synchronism is obtained by an ingenious arrangement for sending a periodical current. On the axis of the type wheel is an arm rotating with it and making contact against a stop, which is released when a current passes through the coils of an electro-magnet, but prevents the further rotation when no current passes. The rotating arms, stops, and electro-magnets of both apparatus are in the same circuit, so that the two type wheels can only be released and commence a rotation at the moment when both arms are, in contact with the stops. Should one arrive sooner than the other, it is held fast until the arm at the other station makes contact. Then both are released by the same current and start together. The contacts for printing various letters are elevated upon a disc of metal which revolves with the type wheel. They are arranged correspondingly with the rotation of the types, but at different distances from the centre and in different sections of the circle. The transmitting contact is made with a spring moved in a line across the centre of the disc by a handle pointing to an engraved alphabet, half of which is on each side of the vertical line passing through the centre of the contact disc. As the disc rotates, one of its elevated contacts meets the spring point and closes the circuit of the battery, sending the current through the relays, which are not moved by the synchronous currents, and, with the aid of local batteries, lifting the printing press. The type wheel is stopped during the printing, but the clockwork, contact arm, and disc continue to rotate. This is done by attaching the type wheel to the axis, not rigidly, but by means of a spiral spring under tension. During the short interval required for printing a letter this spring is simply wound up a little way, and when the printing current ceases

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the type wheel flies round to its stop upon the axis ready to commence another synchronous revolution. This movement is new, and has the advantage that no time is lost during the printing.

Joly's telegraph.

A. Joly, Paris, exhibits a Roman type printing telegraph worked by interruptions of a galvanic current on the principle of that which Jacob Brett used in 1850, on the Dover-Calais cable. The mechanical details are ingenious, but in point of speed it is far inferior to the Hughes. The transmitter consists of a Bréguet's dial plate, with a simple commutator for reversing the poles of the battery at any moment it is required to do so. The receiver is supplied with two clockworks for turning the type wheel and for working the printing press. The type wheel is turned by an escapement released by means of an electro-magnet, whose coils are in the line circuit whenever the armature is attracted to or let go from the poles. The same axis carries also a wheel with spike teeth, which strike against the end of a thin steel spring, and make and break a contact in the circuit of a local battery and the electro-magnet whose armature releases the printing press. The length of the steel spring is made such that its velocity of vibration is less than the velocity with which the spokes of the wheel strike against it. It is thus prevented returning to its position of rest during the time the type wheel is being turned round. When the latter, however, stops, the spring resumes its normal position and closes the circuit of the local battery. On the type wheel are two rows of types—one with letters of the alphabet, the other with numerals, signs of punctuation, &c. The paper strip underneath the type wheel passes in a guide fork over a cushion of india-rubber, which causes it to be slightly elevated in the middle, just where it strikes the type. The position of this cushion underneath one or other of the rows of types is determined by the keeper of an electro-magnet, whose coils are in a second circuit of the local battery, and of a contact tongue formed by a permanent magnet suspended between the poles of the electro-magnet used to release the escapement of the type wheel. The position of this tongue depends, therefore, upon the nature of the currents sent from the transmitting station. If positive currents, it lies upon that side which leaves the second local circuit open, and the cushion underneath the row of letters. When the telegraphist wishes to print numerals, &c., he simply reverses his battery during the time this is to last. In doing so he throws the permanent magnet tongue at the receiving station over to the other side, closing the second local circuit and drawing the cushion under the second row of types. This will be better understood by reference to fig. 3. The

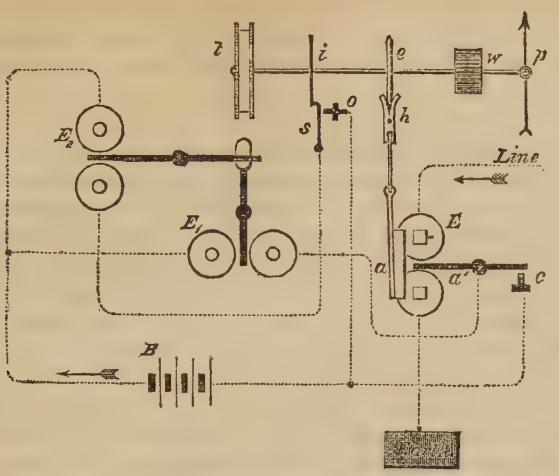


Fig. 3.—PLAN OF CONNECTIONS IN JOLY'S PRINTING TELEGRAPH.

axis of the type wheel carries—1, the disc with double row of types; 2, the wheel of radial spikes for striking the contact spring (*s*) from the contact point (*o*); 3, the scape wheel (*e*), caught by the pallet (*h*); 4, the pinion (*w*), gearing into the next wheel of the train; 5, the pointer (*p*), indicating upon a dial plate the position of the type wheel.

A series of positive currents arriving from the line passes through the coils of the electro-magnet (E), causing the armature (*a*) to oscillate and allow the escapement to turn round step by step. In turning the spokes of *i* strikes against the spring (*s*), which moves too slowly to return to the contact (*o*) until the revolution of the wheel ceases. As soon as this is the case, the first local circuit is closed, and the current of the battery (B) passes through $E_2$, *s*, and *o*, releasing the printing press. If a series of negative currents arrives, the armature (*a*) is moved as before; but the first current also causes the permanent magnet tongue (*a'*) to go the other side and close the contact (*c*), by which the second local circuit (B, E', *c*) is completed, and the armature of E' attracted, draws the cushion of the printing press underneath the second row of types.

The method adopted by Mr. Joly for drawing the paper strip along after each letter is that of a Geneva stop without the convex tooth. The printing press is lifted by a lever attached to a connecting rod, whose upper end is coupled to a crank, making a revolution each time a letter is to be printed. A stop finger on the axis of this crank turns the stop wheel on the axis of the roller, which pulls the paper forward.

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The principal disadvantage of this system is the great expenditure of current, too much work being thrown upon the battery. Could this be remedied, this telegraph would be well adapted for use on private lines where a record is required to be kept.

Morènes' telegraph.

The Spanish Telegraph Direction, Madrid, exhibits a type printing telegraph on the system of Mr. Ramon Morènes, of Madrid, sub-inspector of telegraphs. The transmitter used with this instrument is identical with that of Bréguet's French railway telegraph, having a metal disc underneath the dial plate provided with a sinuous groove, in which a small roller, carried by a lever, runs and communicates an oscillating motion to a spring, thus making and breaking the circuit of a single battery. The receiver resembles that of Mr. Joly, just described. It is provided with two separate clockworks, one for turning the type wheel, the other for lifting the printing press. The mechanism for turning the type wheel contains nothing novel. The latter is carried outside the case of the clockwork, on an axis having a tooth wheel, which gears into a pinion of one-fourth its diameter, upon the axis of the scape wheel. A double pallet, oscillating between the teeth of the latter, is fixed upon an axis at right angles to that of the type wheel, and is regulated in its movements by the armature of an electro-magnet in the line circuit. The printing press is set in motion by a local battery in a circuit including a releasing electro-magnet and a vibrating contact. The latter, which is ingenious, is shown in fig. 4.

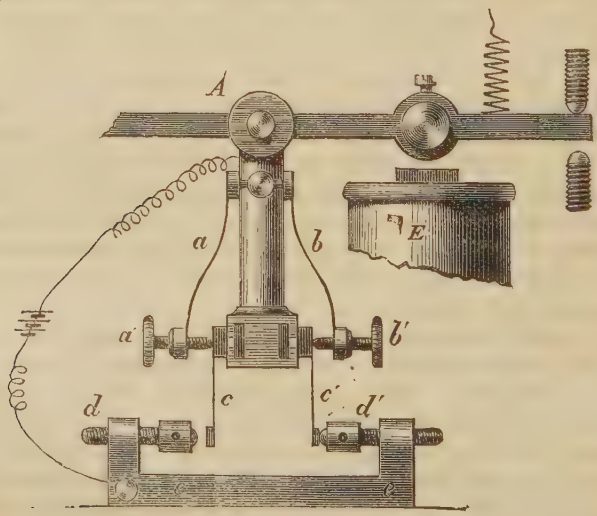


Fig. 4.—VIBRATING CONTACT APPARATUS IN THE SPANISH TYPE PRINTING TELEGRAPH OF RAMON MORÈNES.

On an ivory arm, at right angles to the beam (A), are two thin springs (*a* and *b*), whose heads (*a'* and *b'*) press lightly against the tops of the two arms, *c* and *c'*, one of the latter pressing always against *d* or *d'*—screw points in a common metal piece (*e*). The local circuit is made by way of *b*, *c'*, and *d'*, or by *a*, *c*, and *d*, according as the armature is attracted to the poles or not. Whilst currents are arriving the armature vibrates continually, and the *vis viva* of the screw-heads (*a'*, *b'*) is sufficient to carry either of them off the upper contacts at the same moment that *c* or *c'* meets the lower contact. In this way, until the armature rests on either side sufficiently long to enable the screws to fall back upon the contacts, the local circuit is interrupted and the printing press cannot act. An arrangement is provided for lifting the pallets out of gear of the scape wheel, in order to bring the type wheel back to zero in case it should "skip."

Guyot d'Arlincourt, Paris, exhibits a step-by-step printing telegraph, based upon a principle slightly differing from the foregoing. The type wheel is turned round by a clockwork, regulated by an escapement in connexion with the armature of an electro-magnet, whose coils are in the line circuit. The armature of the electro-magnet operates also as relay in the circuit of a local battery and of an electro-magnet which releases the printing press. When a quick succession of currents arrives, the armature of the printing electro-magnet, which is sluggish, is not attracted, but as soon as the current becomes continuous the printing press is released and is lifted by an eccentric of triangular form. The paper strip is drawn forward between two rollers by means of a ratchet wheel on the axis of one of them, which is caught by a click moved by the armature of the printing magnet.

Levin's telegraph.

The second class of type printing telegraphs, the type and original of which is the self-interrupting instrument of Messrs. Siemens and Halske, in which the receiving portion is set in motion without the employment of clockwork, is represented in the Exhibition by only one apparatus, that of Messrs. Levin and Co., of Berlin. In this telegraph reverse currents of a galvanic battery are used.

The currents put in motion the armature of a polarised electro-magnet, which oscillates a small ratchet on the axis of the type-wheel and pointer between two spring pallets, the same as in Professor Wheatstone's receiver. The type wheel differs from the others exhibited in being formed, not of a rigid disc, but of thin steel springs radiating from a centre, each of which carries a type, as in Siemens and Halske's original dial telegraph. When the armature of the printing electro-magnet is moved it depresses only one of the springs upon the paper strip, and as they are very light the work to

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be done is very little. A second line wire is necessary for working the printing press. The transmitting handle, which turns over the dial plate, is provided with a button, to be pressed down when it is wished to print a letter. The workmanship of this apparatus is excellent, but the whole arrangement displays a want of electrical experience.

## Recording Instruments.

Morse system.

Under this head we understand all the various modifications of the electro-magnetic recording instrument invented by Professor Morse. Its simplicity and facility of manipulation procured for it at an early date, and will probably long retain for it, an almost universal employment. There are quicker systems, but all of them obtain their speed at the cost of simplicity, and they are therefore only applicable in special cases. Morse's invention, made as early as 1832, consists in the mechanical indentation of a strip of paper by a style guided by the armature of an electro-magnet. This primitive form of telegraph, known as the embossing instrument, is the simplest of the class, and is the most useful of all systems from the fact of the apparatus requiring little attention to keep in order, and when a relay is employed not being subject to the varying conditions of the line or the line battery.

Of late years this system has been considerably modified in different countries. In France especially the Morse apparatus has undergone a complete revolution since the adoption by Digney of Thomas John's improvement, consisting in the application of an arrangement for marking the paper with coloured oil instead of by the pressure of a style against it. By this system two important points were believed to be gained, the distinctness of the signals and the reduced force necessary to set the apparatus in motion, by which the relay might be spared. In North Germany a similar instrument, made by Messrs. Siemens and Halske, with some important improvements in the inking part, is employed to a great extent on lines using direct currents. On those lines, however, on which the system of continuous currents or closed circuit is used, embossing instruments in conjunction with delicate relays are generally to be found at work. In Austria embossing instruments with relays are almost exclusively used. The Austrian officials retain the old process, because they have found that their employés seldom or never read by the eye, but by the ear, and only keep the record as a security, agreeably to the regulations of the service. It becomes therefore of little importance whether this record, which is very seldom referred to, is written in ink or otherwise. Another reason for preferring the embosser is that it is free from the disadvantage of the employés having continually to

attend to the inking apparatus which, even with great care and attention, sometimes gives very indifferent results. Mr. Sabine on Telegraphy.

In America the fact that the employés were able to read the messages by the sound made by the armature in striking the poles of the electro-magnet, suggested to Morse the idea of dispensing with the paper altogether and receiving by ear alone. The apparatus so arranged is called a "Sounder," two of which have already been mentioned when speaking of acoustic telegraphs.

Siemens and Halske, Berlin, exhibit an embossing Morse apparatus, completely mounted on a board, with galvanoscope, relay, transmitting key, and terminal screws. Siemens' embosser.

The apparatus consists of a strong clockwork, intended for drawing the paper with a uniform velocity over a roller with a groove in it. Underneath this roller is a metallic style, carried on one end of a beam, the other end of which supports a soft iron armature over the two poles of an electro-magnet. When the armature is attracted by the poles, the style is raised and pressed into the paper underneath the groove, leaving the marks embossed upon it. The relay is of the American construction, and is very delicately adjusted. These instruments are much used on the German railway lines.

Jean Leopolder, Vienna, shows an embossing instrument in which the clockwork is very neatly boxed into a brass case, occupying the least space possible, and keeping the apparatus free from dust. The paper strip is led between rollers over the middle of the apparatus. Leopolder's embosser.

Digney Brothers, Paris, exhibit a Morse apparatus known as their direct-working ink recorder. The purpose of this invention is to spare the use of the relay by making the Morse sufficiently delicate to give marks upon the paper with line currents. The paper strip is lifted by the end of the writing beam which carries the armature against a small metallic disc fixed upon the axis of one of the wheels of the train. This disc is kept inked continually by a little drum of felt, resting upon it and turning with it. Direct-working ink recorders are very extensively used in France. In those stations where much work is done, and the telegraphists are unable to read by ear, these ink recorders are decidedly very practical, as they are easily kept in order with a little constant attention. But where there is little to do the employés sometimes neglect to attend to the felt roller, which, in that case, is found to be continually too dry and it does not mark the paper, or too moist and the ink runs down and makes a blot.

Siemens and Halske, Berlin, exhibit also a construction of direct-working ink writer in which the writing arrangement Siemens' ink writer.

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differs from that of Digney in the writing fluid being contained in a horizontal bottle, the neck of which has a slit for the writing disc to turn in. The paper is conducted between guides and rollers over the disc, which is lifted up to it by the beam when the armature is attracted. The disc is fixed upon one of the axes of the clockwork and turns in the reverse way to the direction of the paper strip.

The cores of the electro-magnet of this instrument are polarised by being fixed upon the north end of a permanent steel magnet whose south end carries the armature. By this, the delicacy of the system is considerably increased.

Vinay's ink writer.

P. Vinay, Paris, exhibits a Morse ink recorder in which the inking arrangement differs from the constructions of both Digney and Siemens (fig. 5).

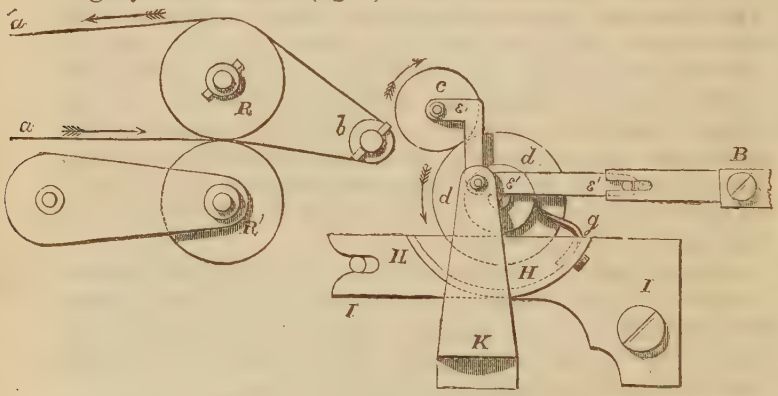


Fig. 5.—P. VINAY'S MORSE INK RECORDER.

The apparatus is provided with a disc (*d d*), rotating in a scraper, the lower part rubbing against a piece of inked felt contained in a shallow dish (*H H*). On the upper left-hand side rides a little jockey disc (*c*) turning upon an axis in the frame (*E*). The frame turns upon an axis in the bearings (*K*). An arm (*E E'*) attached to the frame is provided with a pin held by a fork at the end of the writing beam. The paper strip is drawn between the rollers (*R* and *R'*) over the pulley (*b*), where it is struck by the disc (*c*) whenever the armature of the electro-magnet is attracted and the writing beam lifted, turning the frame (*E*) on its axis. By this arrangement the disc which marks the paper is never overloaded with ink.

Bréguet's ink writers.

L. Bréguet, Paris, shows a Morse apparatus, in which the inking arrangement combines, in his opinion, the best points of both Siemens's and Digney's systems. The writing lever is supported upon a bearing beyond the electro-magnet, so that when the keeper is attracted the writing beam is depressed instead of being elevated, as in the usual form.

The paper runs over a fixed knife edge, and is struck by a disc, moved by the end of the writing beam, and upon the upper side of which a Digney's felt roller leans. The disc is attached to the axis of one of the wheels of the clockwork, and rotates with it. The counter spring of the writing beam has to lift both disc and felt roller, so that the electro-magnet must perform an amount of work which will probably prevent the application of this arrangement to direct recorders.

The inking disc arrangement introduced lately by Professor Sir Charles Wheatstone is superior to any of the foregoing in the clearness with which the signals are written and in the small expenditure of force necessary to move the disc. It consists of a small thin disc of metal turned between two larger discs, one on each side of it, in such a way that the periphery of the smaller or writing disc just enters between those of the two larger ones. The latter are turned in a dish of writing fluid, which is sucked up by capillary attraction between them, and thus presented to the edge of the little disc. When the beam of the Morse is deflected, the little disc is elevated towards the paper strip, and for this purpose only removed a little from its original position between the capillary discs. Both are made to rotate in reverse directions by connection with the clockwork, to give a continually fresh supply of ink to the writing surface.

M. Bréguet has a Morse ink writer in which the parts are arranged more compactly than is usual. This apparatus is shown in fig. 6.

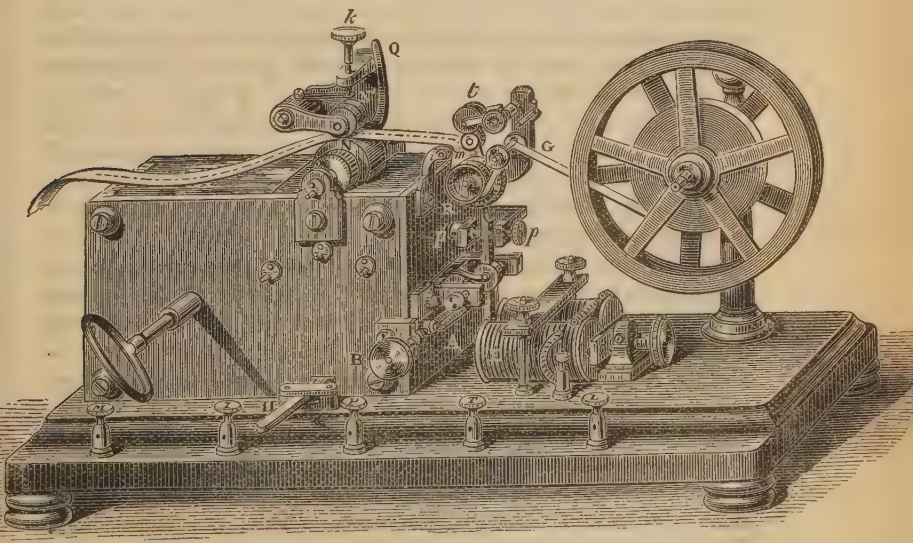


Fig. 6.—BRÉGUET'S MORSE INK WRITER.

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The clockwork differs little from that of the ordinary Morse recorder. The paper strip, which is drawn by the roller (N), passes over the guide (G) underneath the drum (R), whose surface is roughened, then over the thin steel cylinder (*i*). The electro-magnet (E) is horizontal, and the writing beam (*l l*), which carries on its lower extremity the armature (A), and on its upper an arm on which the writing disc (*m*) turns, is vertical. The disc receives a rotating motion, in the reverse direction to that of the paper strip, by means of a pinion on its axis, which gears into a tooth-wheel on the axis of the drum (R). In using this form of Morse apparatus a great convenience is found in being able to read the signals from the paper as they are given, which enables the receiving clerk to stop his correspondent and get a word repeated in case of a mistake without waiting for the paper to pass first between the drawing rollers as in the other form of Morse apparatus.

Hipp's ink writers.

M. Hipp, Neuchatel, shows his ink-writing Morse apparatus, in which the electro-magnet is placed within the metal and glass box containing the clockwork. The purpose of this is to protect the apparatus from dust. The writing beam moves at right angles to the direction of the clockwork. One end protrudes through the front of the apparatus and carries the writing disc. The writing arrangement is like that of Digney's direct working Morse; the general construction is ingenious. The adjustment of his writing beam is a point very carefully attended to by Mr. Hipp. When at rest it is balanced between two spiral springs, one on each side, so that, when the electro-magnet becomes active and commences attracting the keeper towards it, the spring offers no resistance, but its tension becomes greater and greater the nearer the keeper gets to the poles. When the current is interrupted, therefore, the spring has its full force to draw the keeper away, but none to oppose the commencement of its return to the poles. The idea is decidedly a good one, and capable of extension; but the writer is of opinion that it might be done with one spring as well as with two. The force of the spring augments in direct proportion to its elongation, the force of the magnet indirectly to the square of the distance, nearly. Between these two relations a very fine adjustment may, no doubt, be made. There is, nevertheless, a disadvantage in arranging a Morse in this way, arising from the want of sound, when the beam falls back, preventing the telegraphist reading by ear.

Longoni and Dell' Acqua, Milan, exhibit a Morse apparatus on Maroni's principle, with an electro-magnetic keeper. The apparatus is otherwise constructed in the usual way. The main electro-magnet consists of two vertical bobbins

of wire, with soft-iron cores joined by a neutral block underneath. The keeper consists of a simple bobbin of wire, encircling a cylinder of soft iron, whose ends have parallel soft-iron continuations held just over the poles of the main electro-magnet. The bobbin and core of the keeper turn on their axis and move the writing beam. The wire of the three bobbins is connected up in a single circuit, so as to magnetise the ends of the keeper oppositely to those of the electro-magnet. A greater sensibility of action is proposed to be gained by this system, the keeper being attracted to the poles with considerably more force than if it were not encircled by the wire; and, as both are magnetised at the same instant, this armature should respond more quickly to the currents than an ordinary one.

Messrs. Digney Brothers show a similar Morse apparatus.

Sortais' self-starting Morse.

T. Sortais, Lisieux, shows his self-starting and stopping Morse with some modifications in the general appointments of the apparatus. With the usual Morse receiver, when the telegraphist hears the signal for commencing a correspondence he releases the clockwork and lets the paper run. In case of absence or inattention the message cannot be received. To remedy this evil various inventors, and amongst them Mr. Sortais, have proposed arrangements for making the Morse clockwork self-releasing, so that the paper of the receiving station is started by the telegraphist who transmits. Mr. Sortais' releaser is made as follows:—The

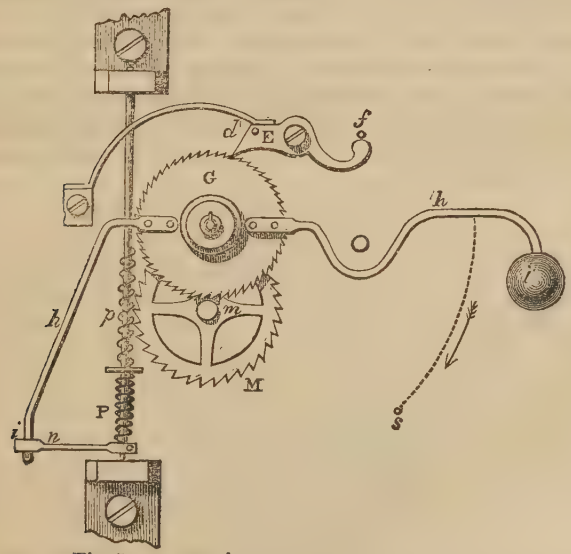


Fig. 7.—SORTAIS' SELF-RELEASING APPARATUS.

last horizontal axis of the clockwork carries a wheel (M), fig. 7, which gears into an endless screw (*p*) upon a vertical axis.

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A thin spiral steel spring (P) is fixed at its upper end to the shaft, and at its lower to a horizontal arm (*n*) which turns upon the shaft. A single projecting tooth (*m*) on the axis of the wheel (M) turns a ratchet wheel (G) upon an axis fixed in the side of the apparatus. This wheel carries, on one side, a bent wire (*h*, *i*), and, on the other, a counterpoise (*i'*) of ten grammes, at the extremity of an arm (*h'*) which tends always to turn the ratchet and lift the bent wire away from the arm (*n*), against which it rests. This is, however, prevented by a click (E), held down upon the wheel by a weak spring. On the click (E) is a pin (*d'*), which goes through a hole in the side of the apparatus, and is so placed that the writing lever, when deflected half way between its highest and lowest points, strikes against it. In repose the arm (*n*) rests against the end (*i*), and the force with which the wheelwork tends to turn the endless screw shaft is balanced by the tension of the spiral spring (P). When a current is received the writing lever is deflected, strikes the pin (*d*), raises the click, and lets the ratchet wheel turn round with its counterpoise, releasing the catch (*n*) from the wire (*i*). As long as currents are being sent the click is continually being struck out of gear. When the reception ceases the click keeps every tooth of the ratchet which is pushed forward by the tooth (*m*) until the wire again blocks the way, and prevents the rotation of the catch. The use of the spring (P) is to allow the tooth (*m*) to get clear of the ratchet wheel, so as not to prevent its release.

Cacheleux's ink writer.

A. F. Cacheleux, Paris, exhibits a Morse apparatus with some historical modifications. Instead of the oil colour used in the writing systems of Digney and Siemens, Mr. Cacheleux employs a reservoir of liquid Indian ink, in which a kind of drawing pen dips. This arrangement is shown in fig. 8.

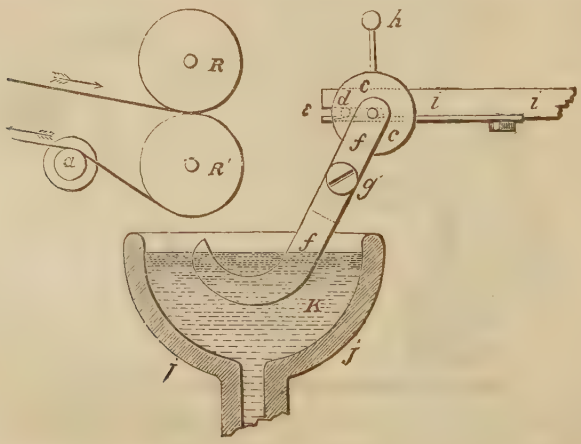


Fig. 8.—MORSE APPARATUS MODIFIED BY A. F. CACHELEUX.

The drawing pen (*f f*), turning upon the centre of the head (*c c*), consists of two thin metallic plates, whose distance from each other is regulated by the adjusting screw (*g*). On the left-hand side of the centre is a pin (*d*), fixed in the flat head (*c c*) of the lever, and held by the fork end (E) of the writing lever (*i i*). In front of this part of the instrument is an inkstand, consisting of a cylindrical reservoir, in which, by means of a screw on the top, a loosely fitting piston of porcelain may be raised or lowered to alter the niveau of the ink. The lower part of this reservoir communicates with the trough (*j j*) in which, when at rest, the drawing pen (*f f*) dips. The paper strip passes between the rollers (R and R′), over the pulley (*a*), and is struck by the drawing pen whenever the armature of the electro-magnet is attracted, and lifts the end of the writing beam, turning the pen upon its axis. Another addition, equally applicable to all Morse apparatus worked with a relay and local battery, consists in placing an alarm bell over the electro-magnet. The hammer is placed upon the top of a bell-crank lever, and turns upon a vertical axis in such a way that it can be set in motion by the end of the beam which carries the keeper of the electro-magnet. It is put in gear by simply turning a switch forward, and put out of gear again by turning it backwards.

Bonet's double style Morse.

The Spanish Telegraph Direction, Madrid, exhibits a double style Morse writer, the invention of Mr. E. Bonet, employé of the Direction. The transmitter consists of a commutator for sending reversed currents. The receiver consists of an ordinary clockwork. The electro-magnet is horizontal, its armature being formed by a small permanent horse-shoe magnet, the horns of which play between its poles. This magnet armature lifts two inking discs, whose lower segments are moistened in a dish of printing fluid, against a common paper strip. At the bend of the horse-shoe magnet a wire is attached carrying a small hammer which plays between two bells of different sizes when the receiver is used as an acoustic instrument. The Direction asserts that this instrument is worked on their lines at the rate of 34 words per minute.

M. Gloesner, Liège, exhibits an ink recording instrument, in which, for greater sensibility, he employs a multiplier of wire and magnet needle, instead of the electro-magnet of Morse's recorder. The axis of the magnet needle carries two arms at right angles to each other, on the extremities of which are small inking discs. The paper strip is drawn longways over the edge of a rectangular prism, and presents a separate surface to each of the inking discs. The idea does not seem to be a very happy one.

Mr. Sabine on Telegraphy.

## Transmitting Keys.

Manipulating keys.

The polarized Morse apparatus of Messrs. Siemens and Halske is constructed in such a way that the soft-iron cores of the electro-magnet are both similarly polarized, whilst to the tongue or armature which moves between them is imparted the opposite polarity. This will be better understood when we come to speak of their induction relay, which is on the same principle. By means of this polarization the soft-iron tongue or armature, being placed equidistant from both poles, is attracted equally by both; being placed, however, nearer to one than to the other, it is more forcibly attracted and held by the nearer pole. When a current circulates in the wire of the electro-magnet it augments the magnetism of one side, and diminishes or reverses that of the other; and the tongue or armature, being polarized, moves to one side or the other according to the nature of the momentary current sent through, and remains there until an opposite current is sent. The transmitting key which sends the currents to this apparatus is only required either to give an instantaneous contact or to produce a current of momentary duration, and therefore magneto-electric currents may be used. The apparatus employed for the production of these currents are called magnet keys.

Magnet keys.

Siemens Brothers, London, and Digney Brothers, Paris, exhibit Siemens' magnet keys. The purpose of this instrument is to telegraph with the Morse apparatus without the use of galvanic batteries. It consists of a battery of permanent steel magnets, between the poles of which a long soft-iron armature is turned through a small angle. The armature has a longitudinal groove on each side, in which a length of silk-covered copper wire is wound. It is so placed in relation to the poles of the magnet, that by pressing down the handle attached to it its polarity is reversed, and a magneto-electric current induced in the wire. An opposite current, of course, is induced when the key is let go back to its normal position. In countries where the galvanic batteries either dry up rapidly or freeze this system is admirably adapted for employment.

L. Bréguet, Paris, has a magnet key by which, with a single permanent magnet, he is able to move the armature of a polarized Morse through a considerable resistance. He does this by quickly removing and replacing a soft-iron keeper between the poles of a permanent horse-shoe magnet, the two horns of which he encircles with coils of wire forming part of the line circuit.

Instead of the magnet key an induction coil has sometimes

been used, the primary wire being connected in the circuit of a galvanic battery and of a common Morse key, and the secondary wire in the circuit of the line, receiving relay, and earth.

Morse keys.

Mr. Bréguet exhibits an improvement on the Morse key for submarine apparatus invented by M. Lacoine. The lever of this key, which is shown in plan in fig. 9, is provided with

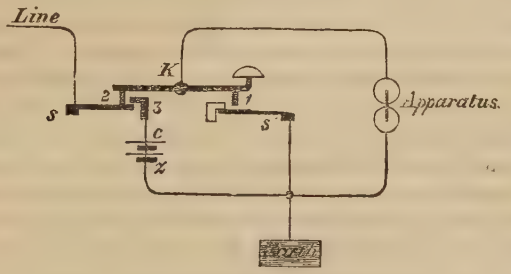


Fig. 9.—LACOINE'S MORSE KEY.

spring contacts front and back. The lever is connected with the coils of the apparatus, the front or working-contact ($s'$) with earth, the back or reposing-contact ($s$) with line, and a contact (3) which the line meets when the lever (K) is pressed down, but which is interrupted when the key is at rest, with the copper pole of the battery. The springs are so arranged that when oscillating the lever remains an instant in contact with both line and earth at the same time. The advantage which M. Lacoine proposes to gain by the employment of this key is the discharge of the line between each signal and the replacing of the relay into the circuit, in order that the receiving station may interrupt the transmission in the event of a misunderstanding, and have the doubtful letters or words repeated without waiting for the end of the despatch, as is necessary in those systems in which the relay is entirely cut off during transmission.

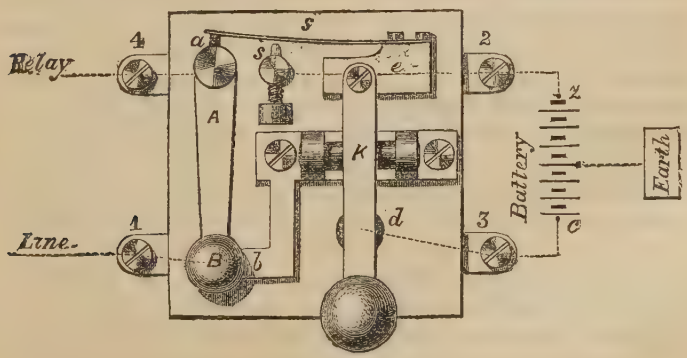


Fig. 10.—SIEMENS BROTHERS' KEY FOR SUBMARINE APPARATUS.

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Siemens Brothers, London, in connexion with their complete submarine apparatus, exhibit a key of a new construction. The beam (K, fig. 10) is connected with the line through the terminal (1); the front contact (*d*) with the copper pole of a battery of galvanic elements. The back of the beam rests upon the block (*e*) of a spring contact (*s'*), which presses against the screw point (*s*) when the arm (A) is turned round, but is separated from it by the agate piece (*a*), when the knob (B) of the lever rests upon the metal cushion (*b*) in connexion with the bearings of the beam. The screw point (*s*) is connected, through the terminal (2) with the zinc pole of a battery. Lastly, the arm (A) is in connexion with the relay. When transmitting, the arm (A) is turned aside, by which the relay is put out of circuit, and the spring (*s'*) connects the battery with the back contact of the key. The zinc current then passes through (2, *s*, *s'*, *e*, K, *b*, 1) into the line. When the beam is depressed upon the front contact the current passes from the positive battery (3, *d*, K, *b*, 1) into the line; and when it is replaced both the circuits are interrupted, and the arriving currents go over (1, B, A, 4) to relay and earth. This key has evidently been introduced as an improvement upon that made formerly by Messrs. Siemens, the beam of which the operator had to turn and hold to the left whilst transmitting. The writer was unable to find the arrangement in this newer construction by which the line is to be put to earth, and the discharge current be prevented going through the relay at the conclusion of each dispatch, as was done by their original key.

M. Villette shows a very useful simplification of the common Morse key. Instead of the common lever turning upon an axis in the middle and striking upon anvil contacts, front and back, M. Villette proposes to use a simple steel spring fixed upon a block of brass at one end, and terminating in a knob, for convenience of manipulating, at the other. When at rest the spring, which is in connexion with the line, presses upwards against a contact point leading to instrument and earth; but when pressed down this contact is interrupted and another established between the spring and an anvil in connexion with the battery. This key, which is cheaper than the ordinary form, and is probably more durable as the axis and bearings are dispensed with, was tried in America a quarter of a century ago, but gave place to the newer constructions.

## Relays.

Relays.

Relays employed in telegraphy are of three kinds; 1, that in which the soft-iron cores of a simple electro-magnet attract a soft iron armature, whenever a current circulates in the wire helices, and presses a contact against a fixed anvil; 2, that in

which the soft-iron cores of the electro-magnet are supported upon one end of a permanent steel magnet, from which they receive similar polarity, whilst the armature or tongue moving between the poles, is oppositely polarized by being fixed upon the other end of the magnet; 3, the so-called galvanometer relays, in which the magnet needle striking against fixed contact stops is made to close the local circuit.

Simple relays.

I. Leopolder, Vienna, shows a relay of the first kind, consisting of a vertical electro-magnet with the usual arrangement of keeper, beam, and contacts. The only novelty in the apparatus consists in the terminals of the line and earth wires each being divided into three parts, with two holes for contact plugs. The two ends of the electro-magnet coils are connected on each side with the first and last pieces, and the line and earth with the middle ones. By altering the places of the plugs, therefore, the coils of the relay may be from time to time inverted to prevent any lasting effects from residuary magnetism in the soft iron. One of the two terminals of the local battery is also divided and supplied with a hole for a contact plug, by removing which the operator can break the circuit of his local battery at pleasure.

A modification of this kind of relay is shown by Messrs. Digney frères, the invention of Herr Wenckebach. It consists of two electro-magnets whose cores are placed in the corners of a square and its soft-iron armature so formed, in four branching arms, that each arm is attracted by a separate pole, when the latter become magnetic. The armature is rather heavy and it would seem that the extra force necessary to put the increased mass into motion is considerably more than that which is gained by the attraction of the extra cores.

Polarized relays.

Digney Brothers, Paris, also exhibit one of Siemens and Halske's polarized relays, the representative of the second kind. In this relay the armature and the soft-iron cores of the electro-magnet are oppositely polarized by contact with a permanent magnet. The steel magnet (N S), fig. 11, is bent into an angular form, which allows the neutral block (*b b'*), from which the soft-iron cores of the electro (*m m'*) branch, to be fixed upon the north end, whilst the south end (*S S'*) is provided with a slit (*B*) in which the pivot of the soft-iron-tongue (*c*) rests. The permanent steel magnet (*N S*) communicates permanent north magnetism to both the poles (*n* and *n'*) of the electro, and

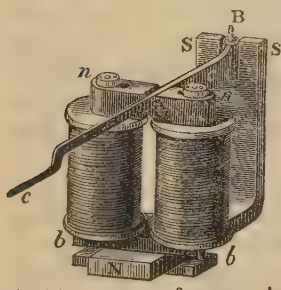


Fig. 11.—SIEMENS & HALSKE'S POLARIZED RELAY.

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permanent south magnetism to the armature, which plays between them. When the armature is equidistant from the poles it is equally attracted by both of them, but takes up a position on either side ($n$ or $n'$) according as this distance is diminished by a force in one direction or the other. The electrical contacts for the local circuit are made by means of screw points, one on each side of the continuation ($c$) of the armature, the latter being supplied with facings of platinum. The soft-iron blocks ($n\,n'$) on the ends of the cores of $m$ and $m'$ are provided with slots and secured by screws, by which their distances from the armature may be adjusted. When an instantaneous current passes through the coils the magnetism of the cores and ends is altered, one of them being strengthened and the other weakened or reversed. The magnetism of the armature, however, remains unaltered, and it moves, therefore, towards and stops on the side where the magnetism is strengthened. Thus the armature of this relay remains always on that side which is determined by the last current sent through it, and does not move from its contact when the current in the line ceases.

Siemens Brothers, London, exhibit a relay and galvanoscope combined. The relay is on the polarized principle, with two vertical bobbins on iron cores fixed upon the north end of a permanent magnet. On the top of the glass cover of the relay under a small glass dome is a single magnet needle supported upon a point. When a current passes through the coils of the relay the polarization of the electro-magnet cores is altered and the needle deflected. The telegraphist who is receiving can therefore see when currents are arriving through the relay without employing a separate galvanometer as has hitherto been done.

Polarized relays were originally intended for use only with magnet keys or induction coils, whence they were called "induction relays," a name by which they are still known. The absence of the adjusting spring of the common relay, however, the functions of which it was found could be more completely performed by adjusting the relative distances of the electromagnet poles from the moveable tongue, combined with the immeasurably greater sensibility of the polarized relay, recommended its employment on lines also worked by galvanic currents.

Galvanometer relays.

Galvanometer relays are now very little used, their sensibility not being nearly so great as that of the polarized. There are none of this kind shown in the Paris Exhibition.

Professor Hughes has found the approximate length of contact with a battery necessary to cause a signal to be recorded through a given resistance of cable to be with Siemens'

relay the $\frac{1}{300}$th, and with the galvanometer relay the $\frac{1}{2000}$th of a minute.* But the galvanometer relays have a merit in being free from those changes and continual adjustments to which all relays are subject which are constructed with cores of soft iron.



## Automatic Telegraphs.

Automatic telegraphs.

The problem of automatic telegraphy is a difficult one; but is one of the most important of those which remain still to be satisfactorily solved. The first automatic telegraph invented was one of the very first published by the telegraph patriarch, Professor Morse.† He proposed to employ a "port-rule" in which metal types were to be arranged and which was to be drawn over two friction rollers or V wheels underneath a contact lever in the circuit of battery and line. Thus the messages were to be set up first in type and then transmitted automatically by the machine. The idea was, however, given up and Morse thenceforth employed only the rocking lever key. Subsequently Mr. Henley proposed in one of his patents to employ magneto-electric currents and an automatic arrangement; but did not publish any further information as to the success or failure of his proposed system. Professor Wheatstone and Messrs. Siemens nearly at the same time proposed systems of transmission by passing strips of paper punched out in holes corresponding with the requisite dots and dashes, under the contact lever of a suitable transmitting apparatus.

Digney's automatic telegraph.

Digney Brothers, Paris, exhibit an automatic transmitter upon this principle. The message is punched out of a strip of paper, which is then passed, with a uniform velocity, between a rotating cylinder and two levers, attached to which light metal springs, whose oscillations between fixed screw points effect the necessary contacts and determine the signals transmitted into the line. The holes are punched out in two rows—one for dots and the other for dashes. The punching is done by means of a key with three levers. The first lever punches out long rectangular holes for the dashes, the second lever only pushes the paper forward, and the third punches out square holes for dots. The paper is drawn forward whenever either of the levers is raised up, after being pressed down; this is done by two brass rollers, with roughened surfaces, on the axis of one of which is a ratchet caught by clicks attached to the levers at different distances from their centres

* Report of Joint Committee, &c., 1861, page 326.

† See Turnbull's Handbook to the Electric Telegraph, 1840.

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of motion. When the middle lever is pressed down its click snaps over one tooth and draws the wheel round so far, when it rises again. When the dot lever is depressed its click snaps over two teeth, and going back draws the paper forward twice as far. The dash lever draws it, in the same way, three times as far.

The transmission of the message is effected by means of a clockwork not differing greatly from that of the usual Morse receivers. The prepared paper strip is drawn between two brass rollers. Before reaching them however, it passes between a barrel or anvil and two light levers which set the contact springs in motion; the latter being in the circuit of line and battery. As the paper passes through, one or the other of these levers falls through the holes and makes contact, the length of the contact being determined by the length of the hole. By this system a speed of 35 words or 175 letters per minute is attainable—about double the speed with which an average telegraphist can work.

Wheatstone's.

Professor Wheatstone has constructed a very beautiful apparatus by which he transmits the messages by magneto-electric currents, using the punched paper strip in the same way. The dots and dashes in his system, however, are given by dots in two separate lines, which renders the writing much more compact than that produced by the ordinary method.

Siemens'.

Siemens and Halske, Berlin, exhibit an automatic telegraph in which the signals are given by a contact lever moved by an arm under which metallic types are drawn. This telegraph, which resembles that originally made by Morse, is a modification of the magneto-electric automatic telegraph shown by the same manufacturers in 1862. The use of magneto-electric currents was found to be attended with certain disadvantages which the galvanic current is free from. The types are arranged in a sort of composing rule. They are of three kinds—dots, dashes, and spaces. Arrangements are also shown for composing and distributing the types. The composing apparatus is supplied with a keyboard. When a key is pressed down a corresponding type falls into a guide, from which it is struck into the rule, each time a letter is completely set. The distributing apparatus is supplied with three holes of different form, agreeing with the forms of the three sorts of types. A rod is forced along the rule, which pushes the types step by step before the three holes, behind which corresponding hammers strike them laterally. The first hole is small, and allows all the narrow or dot types to enter; the second hole is twice as broad, but has a projection at the bottom, over

which only the space types can pass; the third hole is complete, and suits the dash types. A polarized direct working Morse apparatus is used for receiving the reversed currents sent by this apparatus. The positive currents lift the writing beam and produce dots and dashes; the negative depress the beam and produce spaces.

Police telegraphs.

A. V. Bergmüller, Vienna, shows a system of police telegraphs, in which he proposes to use lamp-posts, &c. as branch stations. Two such branch stations are shown, one arranged for a lamp-post, the other for the corner of a building. The branch station consists of a box containing a clockwork and cylinder, with a series of contacts. When the clockwork is released, by pressing down one of a series of buttons, the cylinder revolves and gives the necessary signals to the line. The top buttons are marked "fire, thieves," &c., and the lower ones indicate the street or quarter in which aid is required. The dial plate and buttons are protected by a small iron door, to which the policeman on duty alone has the key. Inside each door is a paper of printed instructions for the guidance of the operator, and above the dial a small galvanometer which indicates if any other station is signalling through the same line, in which case the operator has to wait until the magnet needle becomes quiet. The signals are to go to a central station, where they are received upon the paper strip of a self-starting Morse apparatus.

L. Bréguet, Paris, exhibits a system of automatic repeating signals for use with his railway telegraph. This arrangement is intended for employment on lines having several stations in circuit. When the central station gives a signal, an alarm is sounded at the branch station. This alarm is moved by clockwork released by the current, and gives exactly so many beats as represents the number of the station on the line. Each beat sends a current to the central station, where the receiver of the dial telegraph in circuit indicates the number of currents received. The system is intended to prevent errors and to serve as a security that the right station is being corresponded with. Thus, if the central station "call" No. 5, and receives six beats in return, it is evident that the line is in circuit with a station beyond the required point.

## Copying Telegraphs.

Copying telegraphs.

The copying telegraphs exhibited are of limited number, as might be expected from the demand for them being very small. They are of two kinds, (1) Chemical and (2) Mechanical.

The chemical copying telegraph was invented in 1845 by

Mr. Sabine on Telegraphy.

Mr. Alexander Bain, who has since then endowed his apparatus with a great variety of forms. The principal form used by Bain was that of a revolving disc, upon which the message was laid, and over which a style moving from the centre towards a point of the circumference was slowly drawn, so that as the disc revolved the style described upon the paper a close spiral line. Bakewell adopted a rotating cylinder and a style drawn during its rotation longitudinally from one end to the other, thus describing on the surface a close helix.

Some years later Bonelli in his telegraph dispensed with the synchronism necessary in the preceding arrangements by employing several wires and styles pressing upon types composed upon a horizontal stage.

Caselli's.

The Abbé Caselli has constructed a chemical copying telegraph, shown by the French Administration of Telegraphs, in which he has returned to synchronous movement and arrived at it in a somewhat surer way than by the methods adopted by either Bain or Bakewell. Caselli's telegraph consists of a heavy pendulum at each of the stations, made to swing synchronously by means of regulating electro-magnets. These pendulums move contact styles, which travel backwards and forwards over cylindrical surfaces. On one of these surface is placed the design, drawn in insulating ink upon metallic paper; on the surface of the receiving instrument a piece of paper chemically prepared is placed, the salt of which is decomposed by the current passing through the styles and through the metallic paper. The details are beautiful, but the apparatus is very heavy, and the system at present of little practical importance in electro-telegraphy.

Cros'.

Mr. Charles Cros, of Paris, exhibits a chemical copying telegraph which differs from that of Bakewell in the style travelling round the cylinder instead of the latter turning underneath the style, and in the adjustment of synchronism six times during every revolution. The apparatus consists of a clockwork driven by a heavy weight and giving a horizontal motion to the cylinder and a rotatory motion to the axis carrying the style. By the side of the cylinder and parallel with it is a long screw turned on one of the axes of the train. On this screw travels a nut fixed by a metallic arm to one end of the cylinder, the latter sliding upon a horizontal bar fixed to the side of the apparatus. When the screw turns, therefore, the cylinder is moved slowly along. The style is fixed to an elbow-pin and moves round the cylinder always in the same plane; but as the cylinder moves sideways the style describes upon its surface a close helix. The styles of the two apparatus are arrested and released six times during every revolution for the pur-

pose of regulating the synchronism. This is done by means of a circular disc attached to the style axis, the periphery of which is indented with six equidistant notches. Above this disc is a tooth held in connexion with the armature of an electro-magnet. Whenever this tooth falls into a notch an electric circuit is closed containing the electro-magnets and contacts of both apparatus. Thus the armatures of both are attracted by the same current, and the stop-teeth therefore lifted out of the notches of both at the same instant, allowing the styles to recommence simultaneously another sixth part of a revolution. When one of the apparatus goes faster than the other its style is arrested until the slower one has come up with it and closed the complete circuit of the current, which releases them together.

This plan of adjusting the synchronism is the same as that adopted by Mr. Desgoffe. A relay is used with this apparatus, formed of a common electro-magnet, the armature of which is a tongue of soft iron oscillating between the poles, but held perpendicular by being extended between the two ends of a permanent horse-shoe magnet, with which it, however, does not make contact.

Lenoir's.

The second kind of copying telegraph—that which copies by mechanical instead of chemical means—is shown in the French section by Mr. E. Lenoir, the ingenious inventor of the gas engine.

There are two cylinders—one at the sending and one at the receiving station—which rotate synchronously. On the transmitting cylinder is a design or writing done in insulating ink upon a surface of silver paper, through which the current passes. At the receiving station the cylinder is covered with a thin coat of printers' ink, and has a sheet of tracing paper stretched over it. A style, carried by the armature of an electro-magnet, falls upon the tracing cylinder whenever the current in the line is interrupted, and presses it hard enough to leave a trace of printers' ink on the underside of the paper.

The apparatus consists of a clockwork driven by a weight, which gives rotation to the cylinder, to a horizontal screw for moving the style along it, and to a vertical axis surmounted by a fly wheel and conical pendulum used for regulating the speed. There are two batteries which supply current for the line, one at each station. The current of the battery at the receiving station is added to that of the sending station periodically, so as to give a series of vibrations to the tongue of a relay at the latter station, which closes the circuit of a local battery and two coils of an electro-magnet, over the poles of which revolve the spokes of a star-shaped armature upon a vertical axis. The addition of the second line

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battery for this purpose is done by a commutator on the vertical axis of the receiving apparatus.

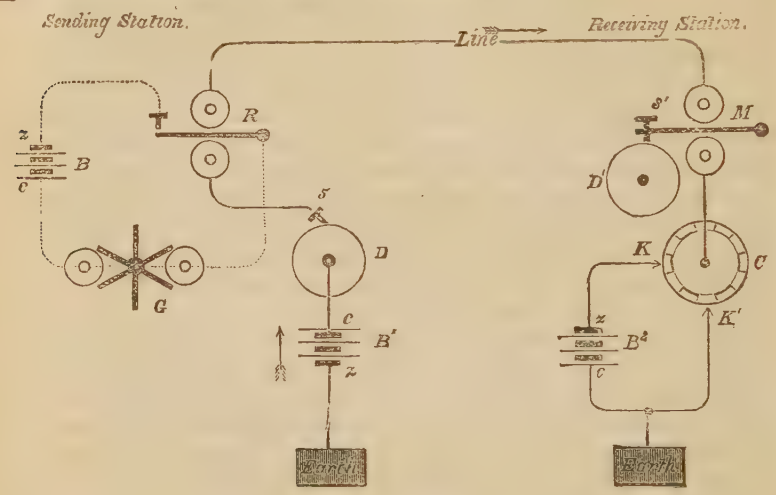


Fig. 12.—PLAN OF LENOIR'S MECHANICAL COPYING TELEGRAPH.

Fig. 12 gives a theoretical plan of Mr. Lenoir's arrangement. The transmitting cylinder (D) turns underneath the contact style (*s*), which always presses upon it. The current of battery B′ goes through the relay (R′) line, coils of the copying electro-magnet (M), and through C (the commutator), either directly to earth through K′, or adds itself to the current of $B^2$ by way of K. The two contacts (K and K′) are placed so that only one is in action at a time, the other being insulated. In either case the current is strong enough to keep up the armature of M, and prevent *s′* falling upon the tracing paper stretched over D′. When, however, an insulated line passes under the point of the style (*s*), the whole circuit is interrupted, and the armature of M, falling off the poles, lets *s′* make a corresponding line upon the paper. The rotation of C gives a series of augmented currents, which set continually the tongue of R in vibration, closing the circuit of B and coils of G. The radiating armature of G is turned by a train of wheels similar to that which turns C, and therefore a spoke of the armature comes always over the poles at the same instant that the current of B′ is augmented by that of $B^2$. And the momentary attraction is sufficient to accelerate or retard the wheelwork which drives the armature of G to accommodate the speed of C.

To prevent residuary magnetism in the cores of M, M. Lenoir coils his wire on the two bobbins, so as to give similar

poles. He lessens the spark, due to extra current, between the two sides of the contact of R by inclosing a condenser of platinum plates in water between the tongue and the contact screw. If copying telegraphs were necessary or useful things, this one, which is certainly the simplest yet constructed, would have the best chance of employment. Mr. Sabine on Telegraphy.

## Lightning Dischargers.

On the continent and in America, where violent discharges of atmospheric electricity into the lines would endanger the apparatus and even the lives of the employés, every station is provided with an arrangement by which the fluid, on entering, is conducted to earth before it is able to reach the apparatus and do any injury. In England, where a small percentage of the apparatus only become injured by the entry of atmospheric electricity into the stations, lightning guards are rarely, if ever, employed, unless it is in the cases of submarine cables, whose insulations, which might be seriously damaged by the high tension electricity reaching their conductors, are considered by our engineers to be of sufficient importance to necessitate their employment. Lightning conductors.

Steinheil, in 1846, was the first who employed lightning guards. His method was to provide the line with a metallic point in connexion with earth, over which the fluid would spring in preference to traversing the coils of the apparatus. Meissner suggested to do the same with plates. Bréguet preferred introducing a piece of very thin wire into the circuit, to be melted as soon as the electricity reached it, and thus cut off all connexion with the apparatus, which, thus insulated, would be free from further damage.

The point lightning dischargers are mostly shown in the French telegraph department. That made by Bréguet for the French Telegraph Administration is formed of saw-shaped teeth cut in the neighbouring faces of three plates of brass, laid side by side upon a common base. The middle plate is put into connexion with the earth, and the two side ones in the circuits of the lines and apparatus. Point dischargers.

A lightning guard is also shown by Digney Brothers, formed by two vertical plates of brass upon a wooden base. From each of these plates are points reaching to within a short distance of the other. One of these plates is put into connexion with the line, the other with the earth.

Mr. Bersch of Paris shows lightning guards for interiors of and for the entrances to stations, tunnels, and submarine lines. The interior guard consists of numerous fine points in a plate of brass in connexion with the line wire,

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over which the lightning springs to a plate in connexion with the earth. The lightning guard for external work is composed of a flat cast-iron box hermetically sealed, with a plate of glass in the front. In the interior are two plates of brass on each of which are erected 500 or 600 vertical sharp-pointed pins, in regular rows, about 10 mm. high, and so arranged that the points of one plate stand exactly opposite and about 1 mm. distant from those of the other. One plate is connected by intermediation of the stalk of a porcelain insulator with the line wire; the other is screwed to the body of the case and from this is connected with the earth plate.

Automatic dischargers.

Another kind of lightning guard is shown by Mr. Bréguet and by Mr. Picco. They are both constructed upon the automatic principal, that is to say, that when the lightning fuses the wire, the line is put automatically into contact with the earth. In the guard shown by Mr. Bréguet, the invention of Messrs. Lartigue and Tesse, electricians to the Chemin de fer du Nord, a length of thin iron wire held between two clamps supports in its middle the head of a lever, the rod of which is hinged to the plate connected with the line wire. When the wire is fused by the atmospheric electricity, the head of the lever released falls by its own weight, causing the back part of it, which is conveniently formed for the purpose, to make contact with the bottom of the earth plate. In this way the line is put to earth and all further danger prevented.

Mr. Picco of Alexandria (Italy) employs a spring to do the same as gravitation does in Tesse and Lartigue's lightning guard. His special arrangement consists in leading the line wire to a brass pillar, on the top of which is a metallic beam turning horizontally, but held in tension by a spiral spring around the pillar. When at work one end of this beam is tied by means of about an inch of fine iron wire to the terminal leading to the instrument. When, however, the lightning fuzes the wire, the spring forces the other end of the beam against the earth terminal, and thus puts the line and the earth into immediate electrical connexion.

Wire dischargers.

Lightning guards are also shown by Mr. Bréguet, such as are sometimes used by the French Telegraph Administration. They consist of a fine silk covered iron wire, coiled upon a cylinder of metal, the latter being put into connexion with earth. The line current has to traverse this spiral on its way to the apparatus. Should, however, the line be struck with high tension electricity, the iron wire is fuzed to the copper cylinder, and completes thus the communication between line and earth.

Siemens Brothers, London, and J. Leopolder, Vienna, show very handsome specimens of Siemens and Halske's plate lightning discharger for four lines. This discharger is made of five plates of cast iron—the lower one, which is connected with earth, stands upon four feet upon the table; the other four are connected in the four line circuits, and lie across the earth plate. They are divided from it by four thin washers of insulating material, leaving a very narrow space of air between the lines and earth. These dischargers are the strongest and most reliable of any.

Mr. Sabine on Telegraphy. Plate dischargers.

In the glass case shown by the French Telegraph Administration, containing a complete collection of the apparatus of various constructions used, at various periods by the Direction, from the Chappé down to the last new Morse telegraph made of Aluminium by order of the Director-General, we find specimens of a lightning guard with a preservative wire, differing in principle however from the foregoing. In the instruments of which we speak the wire through which the lightning passes is intended not to be fuzed, but to be simply expanded by the heat generated by the fluid in passing, and arrangements are made by which this expansion not only puts the line automatically into connexion with the earth, but likewise establishes a communication by which an alarm is put in action for the purpose of giving notice to the employés that the line has been struck.

## Alarms.

Alarms are used: (1), as railway signals; (2), as station signals; and (3), as house telegraphs. We shall therefore divide those shown in the Paris Exhibition under these three heads, according to the employment which the exhibitors themselves intend to procure or have succeeded in procuring for them.

*Railway Signals.*—The most powerful system of railway signals shown in the Exhibition is that of Messrs. Siemens and Halske, of Berlin, employed on the Prussian and North German railway lines. The alarm consists of one or two large cast-iron dome-shaped bells about two inches in diameter and nine inches deep. These bells are supported upon central pillars over the watch boxes of the railway attendants on the lines. The hammers of the bells, which strike them from the outside, are in connexion with levers moved by the running down of a clockwork carrying a heavy weight. This clockwork carries, on one of the axes of the train, a disc with a series of pins projecting from the side, which, catching against the ends of the levers in connexion

Railway alarms.

with the hammers, lift up the latter and let them fall. The clockwork is released by the armature of an electro-magnet, whose coils are put in the line circuit. The wire of the coils is rather thick, so that the weak currents used to send the general messages of the service have not force enough to release the alarms, for which purpose a powerful magneto-electric apparatus, shown in connexion with this alarm, is supplied. These bells may be heard an immense distance off, and, as they are placed at regular distances along the whole line, when a train either starts or arrives at a station notice is given of it to all intermediate points between the signalling and its neighbouring stations. A system is also shown by Messrs. Siemens by which the release of this clockwork is effected by means of a dynamo-electric machine.

M. Bréguet shows a new construction of railway alarm, in which the bell is rung by a hammer lifted by a cam in connexion with a self-acting make-and-break. A plan of this arrangement is shown in Fig. 13. The coils of the electro-magnet, *g*, are inserted between the bearings of its armature, *e*, and the bearings of a metallic contact tongue, *h*. The latter is supplied with two anvil contacts, *i* and *i*, one above it and the other below; the upper one being connected directly with the line, the lower with the zinc pole of a local battery, L B, the copper pole of which is put into connexion with the earth plate. The soft iron armature, *e*, of the

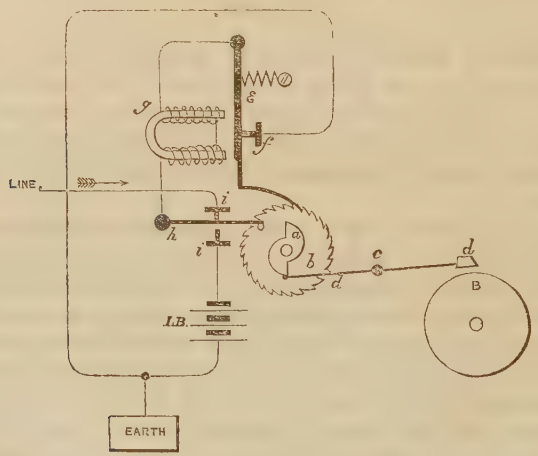


Fig. 13.

electro-magnet is held back by a spiral spring against the fixed contact point, *f*, which is connected with earth. The free end of the armature is provided with a spring which

engages in the teeth of the ratchet-wheel, *b*, and pushes it a tooth round, from left to right, whenever the armature is released from the magnet poles and comes to its position of rest against the anvil, *f*. This ratchet is fixed to a cam, *a*, which, when it turns round, alternately lifts and lets fall the end, *d'*, of the lever, *d c d'*, allowing the hammer carried on the end, *d*, to fall upon the bell, B, twice in every revolution.

When a current arrives from the line, in the direction shown by the arrow, it passes over *i*, *h*, coils of *g*, *e*, *f*, to earth. The electro, becoming active, attracts its armature, and thus interrupts the circuit between *e* and *f*, pulling, at the same time, the spring over the next tooth of the ratchet. The magnet now loses its attractive power, and lets the spring pull the armature back again. In doing so the ratchet is forced round a little, and the pin which held up the contact arm, *h*, against the upper anvil, *i*, passes round, letting the arm fall upon the lower anvil, *i*. A circuit is thereupon closed between L B, *i*, *h*, coils of *g*, *e*, *f*, and so on. This circuit acts as an ordinary self-acting make-and-break until the pin in the ratchet again lifts up the arm, *h*, from *i*, the local contact, and pushes it against *i*, the line contact. In making the complete revolution the cam lifts and drops the hammer twice upon the bell. This system is very ingenious, as little power is required to work the alarm, each stroke being the accumulated force of half as many separate vibrations of the *trembleur* as there are teeth upon the ratchet; and, as their number can be made very great, it is possible to strike a very heavy bell by means of a very light battery.

M. Hipp, of Neufchatel, shows a railway signal in which a series of parallel fans or shutters are moved on a horizontal axis, so as to show a large open space or a closed red field, according to the signal of "clear" or "blocked" which is intended to be given. The movement of the shutters is effected by means of a series of electro-magnets whose armatures are attached to the bearings. The coils of these electro-magnets are in the circuit of a telegraph line, and of a contact and battery at the station from which the signal is to be given. The system is very ingenious, but has little chance of employment in practice, as telegraph connexions have not yet arrived, nor will they probably ever arrive, at a degree of certainty sufficient to allow the safety of human life to be dependent upon their operations.

## Station Signals.

Station alarms.

Mr. Preece shows a fine collection of railway station alarms and signals between passengers and guards. One of

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the most ingenious things shown by Mr. Preece is a signalling apparatus for giving notice when a lamp goes out. As much inconvenience and danger may be occasioned by a signal lamp getting out of order Mr. Preece places immediately over the flame a strip of brass which expands with the heat and presses upon the shorter end of a lever by the longer arm of which a contact with an electric battery is interrupted. As soon, however, as the lamp goes out the brass gets cold, contracts, and allows the contact to be re-established by which a bell is rung or some other signal given in the station.

For station signals, and in connexion with this lamp apparatus, we see a very ingenious application of magnetic attraction, by which a disc is made to turn round from the red to the white side, and *vice versâ*. This is done by an electro-magnet E (Fig. 14), whose armature *a* is composed of a cylindrical tube of soft iron cut away between *b* and *c*, supported excentrically to its geometrical axis, and held by means of a spring, so as to be, when at rest, at its greatest distance from the pole. When the latter becomes magnetic the armature is attracted and turns round its excentric axis in the direction of the arrow, bringing it continually nearer to the poles until its nearest point is reached. When the current ceases the spring pulls the armature back again.

Fig. 14.

## House Telegraphy.

House alarms.

In the various exhibitions of house telegraphs there is nothing whatever shown which was not shown in the London Exhibition of 1862. The only point worthy of notice is that the workmanship generally appears better and the prices more moderate.

House telegraphs are shown by Bréguet, Caumont, Prud'homme, and Digney in the French, and by Bellé in the Prussian Department.

The only peculiarity in these is the manner in which they are arranged for convenience and freedom from disarrangement. One of Bréguet's systems contains a bell, in the circuit of which are two contacts. One of these contacts is

pressed by the person wishing to give the signal, by which the bell is set ringing until the other contact is pressed by the person signalled, by which the circuit is interrupted and the bell stopped.

## Electric Clocks.

Electric clocks.

Since the date when Steinheil and Wheatstone first started the subject of electric clocks and chronometers, every year has brought forth new inventions and patents, and as often do the inventors and patentees make the discovery which Steinheil and Wheatstone did, that it is cheaper, safer, and easier to lift a pound weight from the ground three feet high, with the human hand, directly or indirectly, and let it fall in a week or ten days, back again, pulling round a clockwork with it in its fall, than to get the same amount of work out of a galvanic battery. Some of the electric clocks work well and regularly, as for instance that at the Greenwich Observatory, made on the ingenious principle of Shephard and some others; but the trouble of attending to the batteries is infinitely greater than the trouble would be of winding up the clock occasionally.

Levin, Berlin.

Levin and Co., of Berlin, and Prud'homme of Paris, exhibit an electric clock on the Shephard principle, that is to say, every time the pendulum swings in one direction, it makes an electric contact with a battery and the coils of an electro-magnet whose armature, on being attracted, hangs a weight or presses a spring upon one side of the pendulum rod, causing it to receive an impulse in its back oscillation. It is evident that in this system much power is lost, because the pendulum does not require a fresh impulse for every beat, but only just sufficient to balance the force lost in friction on its bearings and in the air. To obviate this needless expenditure of force, Mr. Hipp, of Neufchatel, has constructed a clock whose pendulum in swinging carries a short arm over three teeth placed upon the upper side of a spring contact, closing thereby the circuit. Figure 15 gives a theoretical sketch of this arrangement. The pendulum rod, A B, in swinging from left to right, as shown by the arrow, draws the little arm G, which is hinged upon it, over the three projecting teeth H. If the elongation of the pendulum is sufficient the arm G, after riding over the last tooth will swing and be dragged freely back again over the teeth; but if the elongation is not sufficient to carry it over the last tooth, the pendulum in returning against the arrow will cause the arm to sit fast in the space between the first and second teeth, and to press down the spring C C′, which has its fixed point at C, upon the anvil-contact D. In doing so the electric circuit of the

Hipp, Neufchatel

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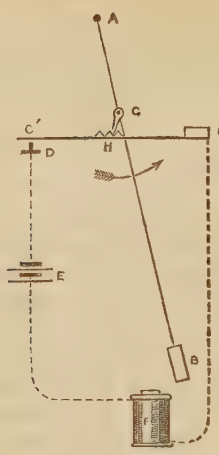


Fig. 15.

battery E, shown in dotted lines, is closed, thereby exciting the electro-magnet F, and enabling it to attract the bob E of the pendulum, which has a soft iron armature attached to it on purpose, thereby giving the pendulum a new impulse. Thus, the galvanic circuit is only closed when the elongation of the pendulum falls below a certain given angle, and, as the impulse is energetic, this decrease, which is caused by resistance of the air, by friction in the bearings of the pendulum, and by inductive action caused by residuary magnetism in the coils of the electro-magnet F, and the moving armature, B, only occurs on an average after every five or six oscillations. By this simple arrangement two important points are gained; very little galvanic power is employed, that it to say, only enough to compensate the friction, &c., and the metallic contact lasts five or six times as long as when a contact is given for every oscillation.

## Measuring Apparatus.

Measuring apparatus.

Dr. H. Meidinger, Carlsruhe, exhibits a galvanometer, consisting of a tangent needle, with a long vulcanite pointer indicating upon a dial divided into degrees of force. The unit of these degrees is the weight of hydrogen gas developed by the current in an hour. The instrument is supplied with three terminal screws, which may be variously connected in circuit, giving various values to the unit of weight expressed by the scale, as follows:—

With screw No. 1 each degree represents 0·0001 grammes.
„ Nos. 1 and 2 „ 0·0010 „
„ Nos. 1, 2, and 3 „ 0·0100 „

the last being equivalent to 112 cubic centimetres of gas, at 0 deg. cent. temperature, and 760 mm. barometer.

By simple multiplication of the degrees of force indicated upon the circular dial-card with the equivalent weight of any metal, therefore, the absolute weight of that metal reduced from its solution by the current in one hour is found.

Cable board.

Siemens and Halske, Berlin, exhibit a complete testing board, with galvanometer for cable work. The board is arranged with two boxes of resistance coils, one with duplicate 10, 100, and 1,000 mercury units, for the proportion

resistances of Wheatstone's balance, the other with resistances from 1 to 10,000 units. A commutator of novel construction allows these resistances and the circuits of the board to be arranged for measuring copper resistance; insulation by balance, deflection, and differential methods; charge, discharge, electro-motive force, and the necessary constants. The battery commutator is divided, to allow any number of elements from 5 to 100 to be inserted at once.

The galvanometer is constructed upon the differential principle. An astatic needle is surrounded by a coil of thin copper wire, whose magnetic effect upon it is very great. A second coil, placed vertically upon a movable stage outside the case of the instrument, is adjusted so as to exert from 0·001 to 0·0001 times the magnetic effect of the larger coil upon the needle. The cable whose insulation by differential method is to be measured is inserted, with a battery in the circuit of the larger, whilst a known resistance and single element are inserted in that of the smaller coil, whose distance from the needle is varied until the latter rests over the zero line, at which moment, therefore, the magnetic effects of the two currents upon the needle are equal and opposite. Knowing the relation of the initial effects of the two coils at the same distance, the electro-motive forces, and resistance inserted in the smaller circuit, the resistance of the cable is easily calculated.

Differential resistance measurer.

Siemens Brothers, London, show a differential galvanometer for measuring small resistances without the aid of resistance scales. The needle is balanced between the opposite magnetic effects of two separate coils of wire, which retain always the same distance from each other, but are moved together horizontally in a plane at right angles to that of the magnetic meridian. Therefore, the magnet needle may be midway between them, in which case they exert, with equal currents, equal and opposite magnetic effects upon it; or it may occupy any other point between them, in which case the needle is balanced by the stronger current circulating in the more distant coil. A common battery is used for both coils, a constant resistance being included in the circuit of one of them, and the unknown resistance in that of the other. The coils are then shifted until the needle rests over the zero line. This is done by means of a metal curve moved by a micrometer screw at right angles to the stage which carries the bobbins, and against which an agate point on the stage is pressed by the force of a spring underneath. The curve is graduated in terms of the mercury unit, so that the resistance of any wire may be read off directly without the intervention of Rheostats, or the necessity of calculations.

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*Niveau* indicator.

Siemens and Halske, Berlin, exhibit an apparatus constructed for measuring the height of water in a reservoir by means of magneto-electric currents. A pitch-chain, fixed at one end to a float on the surface of the water, passes over a cog-wheel, and carries at the other end a counterweight. When the water rises, the float, rising with it, lets the counterweight down, and turns the cog-wheel in one direction. When the water falls, of course, the cog-wheel is turned in the reverse direction. On its axis is fixed one end of a helical spring, which is wound up or unwound when the wheel turns. The other end of the spring is fixed to a soft-iron barrel armature, the wire of which is wound longways. When the cog-wheel has made a complete revolution, and either wound up or unwound the spring, the barrel armature is released, and the spring in regaining its normal position twists it round between the poles of a battery of permanent magnets. In turning, the sides of the soft-iron barrel take alternately different states of magnetism, and, therefore, induce different currents in the wire upon it. The direction of these currents depends upon the direction of rotation, two currents being given for each revolution, one way positive-negative, the other negative-positive. This is essential for the operations of the indicating instrument, which is moved only by the last current each time. The currents following the rising and falling of the water are sent through different lines. This is attained by a mechanical arrangement, one end of the wire upon the barrel being attached to an insulated ring, on which is a clip with a short arm pressed against one or other of two fixed contact points, according to the direction in which the barrel is turned. These two contact points are in circuit with the two lines. Thus all the currents induced whilst the water is rising are sent through one of the lines, those induced during the time the water falls through the other. At the receiving station, where the indication is required, the two lines are connected with the coils of two polarised electro-magnets, whose armatures end in spring pallets catching into the teeth of two ratchet wheels. Each of these wheels is fixed upon a hollow axis, which carries also a crown wheel. The teeth of the two crown wheels are directed towards each other, and between them gears a pinion turning upon an axis fixed at right angles upon the central axis of the system. Whenever, therefore, one of the electro-magnets is set in action its armature, attracted and repelled, pulls round, step by step, one of the ratchet wheels, and causes the pinion between the crown wheels to turn half as many teeth in the same direction. The pallets of the armatures engage with the teeth of the ratchets on opposite sides,

and therefore turn them in opposite directions. The central axis carries an index which denotes upon a circular dial the positions of the float upon the surface of the water.

Wave "wippe."

Messrs. Siemens Brothers, London, show an apparatus for measuring the velocity of galvanic waves in submarine cables. This consists of a clockwork driven by a weight, and regulated by a chronometric governor,* the invention of Mr. C. W. Siemens. Two systems of contacts are employed according to the velocity required driven by eccentrics attached to different points of the train, and one of which oscillates six times as fast as the other. Each system consists of two tongues of thin platinum, oscillating between four fixed contacts. The contacts and tongues are represented in the theoretical plan (fig. 16) by *d*, *d'* and *e*, *e'*, the former of which vibrates six times as fast as the latter.

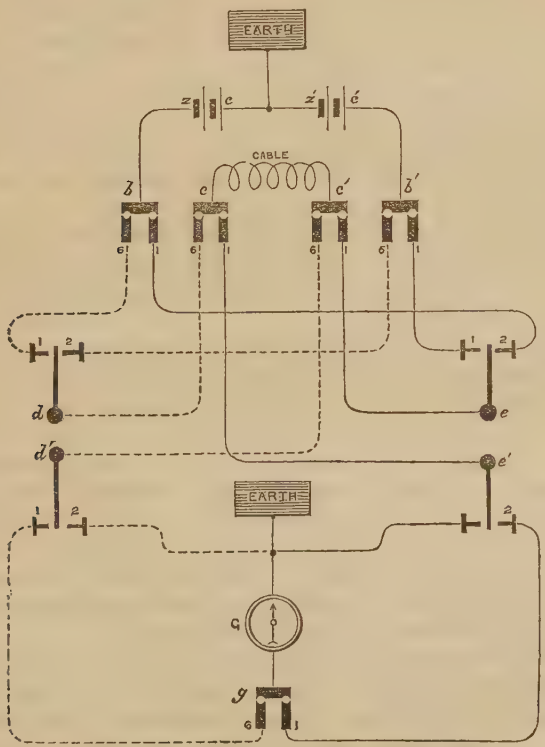


Fig. 16.

* On Uniform Rotation, by C. W. Siemens, Phil. Trans., 1866, April 12.

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The oscillations are adjusted so that the tongues, $d$, $d'$ and $e$, $e'$, make contact with their contact screws, 1 and 2, on each side at the same instant, rest upon them the same time, and leave them again at the same instant. The apparatus is supplied with a series of terminal screws, marked 1 and 6, to indicate the holes into which the contact plugs must be inserted in order to bring the system, $d$, $d'$ or $e$, $e'$, into play. Between these terminals and the various parts of the apparatus are permanent connexions, shown by lines in the diagram, the dotted lines representing those circuits which are peculiar to the faster system.

The governor regulating the speed of the clockwork is constructed with a parabolic cup open at the bottom and top, and which rotates in a dish of oil or other fluid, and lifts it by centrifugal force over the upper rim, when the velocity of rotation exceeds the normal velocity of the apparatus. As soon as this is the case the fluid lifted over expends its rotatory force against a series of fixed fans, and falling upon the outer periphery of the cup has a second time to be accelerated. The force required for this acceleration may be made equal to the extra force applied to increase the flow of fluid, and thus the velocity of rotation may remain the same, or even decrease with an increased driving power.

By varying the height of the fluid in the dish, the normal velocity of rotation may be varied between the limits of 1 and 6; and, as there are two systems moving at velocities having a fixed relation also of 1 to 6, it follows that by varying the height of the fluid and changing also the places of the contact plugs, the effective velocity of the contacts may be varied between 1 and 36, in a given unit of time. $z$ $c$ and $z'$ $c'$ are two equal batteries whose point of junction is to earth, their remaining poles being attached to the terminals $b$ and $b'$ respectively. The cable is connected between the terminals $c$ and $c'$, and a galvanometer between earth and the terminal $g$. When the tongues, therefore, oscillate, alternate + and — currents enter the cable, of which only the zinc currents pass through the galvanometer, the copper currents passing direct to earth.

For the measurement of the velocity of waves in cables it is important to be able to alter regularly the speed of the contacts in order to observe with certainty the neighbouring points of maximum and minimum current, and for this purpose the chronometer governor is said by its inventor to be highly applicable.

## Batteries.

The show of batteries is a poor one, and, in addition to the already old systems, there is only one shown in the Exhibition which can make any pretence to newness. Galvanic elements.

The element in question is due to M. Leclanché, of Paris. His element consists of a positive pole, formed of a prism of carbon surrounded and lightly packed into a pulverized mixture of peroxide of manganese and carbon, contained in a common porous pot; and of a negative pole, formed of a cylinder of amalgamated zinc contained in a solution of sal-ammoniac in water. The theory of this element is very simple. The circuit being closed the current decomposes the sal-ammoniac. The chlorine combines with the zinc; the hydrogen and ammoniac go to the positive pole and reduce the peroxide of manganese in exact measure to the strength of the current passing at the moment. M. Leclanché very justly observes in his prospectus that the peroxide of manganese, mixed with the carbon, being a good conductor of electricity, the system may be regarded as a single fluid element, in which the positive pole is formed of an artificial metal having a great affinity for hydrogen. One decided advantage possessed by this element over those in which two liquids are employed is that endosmose is entirely absent. It is not easy to understand, in regarding his element, why the inventor has adopted zinc cylinders of so small a surface; it is true that even amalgamated zinc is not attacked in a solution of ammonia; but as the consumption of zinc must be proportional to the current generated, we should have thought that a larger zinc plate would have had the double advantage of lasting longer and offering less internal resistance. As to the peroxide of manganese, there is no doubt that it is insoluble in an ammoniacal solution; and, therefore, this element ought to be a clean one when in action and not deteriorate when left in open circuit. Manganese element.

We have employed this combination, and have found every reason to be satisfied with it. The electro-motive force of such an element is about 1·3 Daniell's, and its resistance in its present form about 6 Siemens' units.

The remaining batteries exhibited are modifications of either Daniell's, Smee's, or Marié Davy's constructions. A modification of the former is shown in the Roman Court, in conjunction with the meteorograph of Father Secchi. This battery resembles that known as Minotto's. Each element is contained in a cylindrical glass jar. At the bottom of the jar is a star of sheet copper connected to an insulated wire passing out of the side of the element. Upon Secchi's element.

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this sheet of copper, which acts as the positive pole, is a depth of about one inch of sulphate of copper crystals covered by a disc of flannel. Immediately upon the latter is a thickness of sand, and, above this, the ring of amalgamated zinc, surrounded by sand. Father Secchi informed the jury that this element, when once charged, retained its original force for six months without requiring any further attention than the occasional addition of a few drops of water.

"Balloon" Meidinger.

For working his electric clocks, M. Bréguet uses the element shown in figure 17, called generally a Balloon Meidinger. This battery is simply a modification of Daniell's, suggested by M. Vérité, of Beauvais. The balloon, B, is filled with crystals of sulphate of copper and water. The neck of the balloon is provided with a cork, in the centre of which is a glass tube reaching just underneath the surface of the liquid.

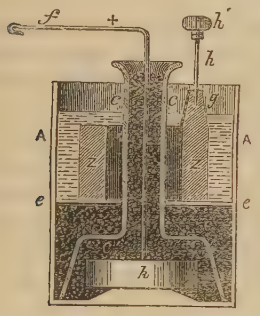
Fig. 17.

In the centre of the jar is the common porous pot, containing a copper pole, which is connected with the strap + ; and around the porous pot a cylinder of zinc, D, connected with the strap —. When the element is in action the sulphate of copper solution becomes decomposed, and its specific gravity has therefore a tendency to become lessened. But the heavier solution from above diffusing itself below maintains the liquid at the point of saturation. When these elements are covered closely by the wooden rim and balloon very little evaporation takes place, and they remain clean and constant as long as there is any sulphate of copper in

the solid form in the balloon. By endosmose the liquid in the glass is always lower than that in the porous pot, the latter retaining an almost invariable height, because, as soon as by evaporation the *niveau* of the liquid in C sinks, a bubble or two of air rises into the balloon and allows just so much solution to run out as suffices to close up the mouth again.

Siemens' Daniells'.

Siemens and Halske's battery is also a modification of that of Daniell's, in which the porous diaphragm is increased considerably in thickness, for the purpose of preventing as much as possible the diffusion of the sulphate of copper solution into the compartment reserved for the zinc pole, and therefore the reduction of metallic copper, not due to electric current. This element is contained in a cylindrical glass or earthenware jar, eight inches high and five in diameter, shown in section in fig. 18. The copper pole, *k*, is formed in a spiral, and attached to the copper wire, *f*+. Above this pole and surrounding the wire, is a bell-shaped funnel, *c*, *c*, *c*, made of porous pot-ware. This funnel is held in place by being closely packed in a quantity of papier-maché or sawdust to the height shown by the line, *e*, *e*. Above this is a disc of brown paper or cotton cloth, upon which rests the zinc cylinder, *z*, *z*, its neck *g* standing out of the liquid in the vessel and carrying the connexion screw, *h'*.




These elements are used extensively in telegraphy in Germany, and have been employed by the writer, with advantage, in cable measurements. The electro-motive force of each element is, of course, the same as that of the ordinary Daniell's, and its resistance about 4 Siemens' units.

Sartori's Smee.

A modification of Smee's battery is shown by M. Leopolder of Vienna. It is constructed by M. Sartori and is arranged in a very convenient form. Instead of the platinized silver used in Smee's original battery, M. Sartori employs plates of carbon platinized. The carbons are prepared by being coated first with a thin film of metallic silver, by electrolysis from a solution of nitrate of silver in water. After they have received this coating they are platinized in a solution of chloride of platinum in dilute sulphuric acid. Two such platinized carbon plates are employed in each element with an amalgamated zinc plate between them, and immersed in a solution of one part of

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sulphuric acid to nine parts of water. The element is contained in a glass jar with a glass lid perforated for convenience of making connections with the poles, and secured by a collar of india-rubber. A battery of this kind is said to be very well adapted for electro-plating or for use in local circuits.

In the Austrian exhibition we meet with a couple of Smee's elements arranged in a neat box, together with ten small Marié-Davy's elements. The Smee's are intended to be used as local battery, and the Marié-Davy's as line battery in a portable station. The arrangement of the latter is due to Dr. Hermann Militzer of Vienna.

Von Ebner's Smee.

The battery used by the Corps de Genie of Austria consists also of a modification of Smee's. The elements are of large dimensions, being contained in high glass cylinders. Instead of the platinized silver used for the positive poles of Smee's element, the Austrian officials use platinized lead, which has the advantage of greater cheapness. The negative pole is formed of odd pieces of sheet zinc partly immersed in a cup of porcelain containing mercury. It is believed that by this arrangement the loss of zinc and mercury is considerably reduced, and that the great volume of liquid employed lessens the influence of its changing resistance upon the current.

Farmer's thermo-pile.

A thermo-battery is shown by Mr. Farmer of Salem (Mass.), consisting of alternate strips of copper and blocks of an alloy of zinc and some other metal not stated. The blocks are cast in the form of wedges, 2″ long, 1″ deep, and tapering from $\frac{1}{2}$″ to $\frac{1}{4}$″, so as to be conveniently placed in a ring, leaving a central space of about 2″ in diameter open, into which a rose gas burner is introduced. Between each wedge-shaped block is a copper strip insulated from the alloy by means of an intervening plate of mica, and soldered to one block at its inner and to the neighbouring one in the middle of the outer end. These blocks, &c. are held together by being clamped between the circular top of a cast-iron tripod stand and a cast-iron ring. The electromotive force of a battery of this kind, containing 36 pairs, is stated by the inventor to be equal to that of a Grove's element. The internal resistance is given as equivalent to that of a copper wire No. 18 gauge, 60 feet long. The current is said to be able to disengage 12 cubic feet of gas per hour. In an experiment which we made with this battery, it was found that the conduction of heat from the interior to the exterior ends of the elements was so rapid as to cause the difference of temperatures to be considerably reduced, so that at starting the electro-motive force was

comparatively high, but went down after the battery had been at work for half-an-hour.

Polarisation battery.

J. Thomsen, Copenhagen, exhibits his polarisation battery. This apparatus is based upon the separate polarisations of a number of platinum plates, which are discharged in series. The battery consists of 50 small cells, divided from each other by platinum plates, and containing dilute sulphuric acid. If *a*, *b*, *c*, *d*, *e*, . . . be such plates, and we bring the carbon pole of a galvanic element to *a* and the zinc pole to *b*, the opposite surfaces of *a* and *b* will be polarised, hydrogen will be developed on *b* and oxygen on *a*. Therefore, on removing the battery, *b* remains the + pole and *a* the − pole of the gas element, *a*, *b*. Instead of removing the galvanic battery, let us shift the connections from *a* and *b* to *b* and *c*, so that oxygen is now developed on the other side of *b* and hydrogen on *c*, then to *c* and *d*; and so on. At the end we shall have the electro-motive force of so many oxy-hydrogen elements. Mr. Thomsen employs 50 plates, and makes the contact by means of a rotating commutator, which shifts the contacts of the battery on to the first two poles the instant after they leave the last two. The first and last plates are joined by a wire permanently with the terminals of the system, and between them a continuous current is kept up.

The writer made experiments in the Exhibition on the electro-motive force between the terminals when two Bunsen's elements were used for charging the battery, and the commutator rotated 38 times (or charged 1,900 elements) per minute. The electro-motive force was equal to 70 Daniell's elements.

## The Dynamo-Electric Machines.

Conversion of mechanical effect into electric current.

One of the newest things in electricity shown in the Exhibition is the apparatus for the conversion of mechanical effect into electric current. In the further development of the system there can be no doubt that it will, at a later date, form one of the principal methods, if not the only one, for the production of steady lights. At present, however, it is in the transition period from the laboratory to the lighthouse and telegraph office, and although it has not yet reached either is entitled to a place here.

The term dynamo-electricity means simply electricity which is obtained from mechanical motion, without the use of permanent magnets, in contradistinction to magneto-electricity, which is produced equally by motion, but in which permanent magnets are indispensable. The two electricities are, however, of precisely the same nature, the only

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difference being that, in the one case an electro-magnet, and, in the other, a permanent magnet is employed for affording the necessary induction. As the dynamo-electric method is new, in fact the only new thing in electric science, it may be interesting to glance at its history.

Wylde.

On the 26th April 1866 Mr. Wylde, of Manchester, published a paper upon results obtained by a very ingenious combination of Siemens' barrel-armatures, by which he had succeeded in producing astonishing magneto-electric effects.* This combination consisted of two inductors of the barrel form, one turning between the poles of a battery of permanent magnets, the other and larger of the two, between the poles of an electro-magnet, whose wire coil was put into circuit with the wire of the first barrel inductor. The wire of the second inductor was led away to a lamp, or wire, or otherwise to the point where it was wished to manifest the effects of the resulting current. This apparatus was, therefore, simply a Siemens' barrel inductor in which the battery of permanent magnets was replaced by an electro-magnet, and this electro-magnet set in action, not by a battery, as is commonly the case, but by the commutated currents of a second and smaller barrel inductor. Mr. Wyld deserves all the credit which he has obtained for the ingeniousness of his combination. The effects which he produced by this machine are greater than those produced by any other of the same dimensions.

The publication of this apparatus suggested and was followed almost immediately by an invention of one in which the permanent magnet inductor was dispensed with, and the current of the barrel coil of the electro-magnet inductor conducted, through a commutator, to the coil of the electro-magnet itself. Thus the circuit of the whole apparatus was simply closed in itself, and the effects were found to be in correspondence with that which was to be expected.

The theory of the arrangement is this :—In the soft iron poles of the electro-magnet is always more or less residuary magnetism. No soft iron on the earth's surface can exist without magnetism ; because the earth itself is a magnet, and a strong one. However little magnetism may be in the iron, when the barrel coil is turned round, two currents are induced in it which are weak in proportion to the weakness of the magnetism in the iron. These currents are, however, conducted in the same direction by means of the commutator, round the wire-coil which encircles the electro-magnet,

* Experimental Researches in Electricity and Magnetism ; Proceedings of the Royal Society, Vol. XV., p. 107.

and increase, to a slight extent, the magnetism already existing in it. In consequence of this augmentation, the next following revolution of the barrel produces somewhat greater currents, which, in their turn, still further augment the magnetism of the soft iron, causing the third current to be still stronger, and so on. Thus in turning the barrel armature round repeatedly, the magnetism of the cores increases to such an extent that, after fifty revolutions, a very considerable expenditure of force is necessary to continue the revolution.

This expenditure of force is greater than that which would be necessary were permanent magnets instead of soft iron employed. The great magnetic difference between steel and iron consists in this, that steel has the property of retaining the principal part of its polarization when, by means of any source, it is rendered magnetic; whereas, iron on the contrary, although it takes nearly a third more magnetism than steel, retains only an infinitely small part of it when the magnetising source is removed. It is on this account that, on beginning to turn an apparatus of this construction, the magnetism and currents are, at first, scarcely perceptible; but that, by continuing to turn, they become at least one-third stronger than would be possible if the iron cores of the electro-magnet were replaced by steel magnets of the same dimensions.

The apparatus is, in fact, in the purest sense of the word, a convertor of mechanical effect into magnetism and into electric currents.

The suggestion of such a construction was first made known by Dr. Werner Siemens in a paper presented to the Berlin Academy of Sciences by Professor Magnus, on the 17th January 1867.* To Professor Wheatstone the idea seems also to have occurred about the same time or soon afterwards, as we learn by a paper read by him before the Royal Society, on the 14th February in the same year.† At a later date Mr. Ladd, optician of London, proposed to modify the apparatus designed by Dr. Siemens and Professor Wheatstone by the employment of two rotating armatures between the poles of the same electro-magnets. One of these armatures he proposed to use for magnetising the cores of the electro-magnet, and the other for receiving the resulting current. Thus the apparatus would take a form between that of Wyld and that suggested as above.

* Monats Bericht der Königl. Akademie der Wissenschaft zu Berlin. Jan. 1867.

† Proceedings of the Royal Society, Vol. XV., p. 369.

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In some experiments which were made by Dr. Siemens before the publication of Mr. Ladd's modification, this form of apparatus was found to give very excellent results, and to have the especial advantage that the work done by the resulting current is quite independent of the current produced for the magnetising of the cores, so that the maximum of magnetism may be maintained in these notwithstanding the work which is being done in the other circuit. In the Paris Exhibition are shown three apparatus for illustrating dynamo-electricity. The largest and original one of these is shown by Messrs. Siemens and Halske, of Berlin. It consists of a Siemens' barrel armature, 3 inches diameter and $2\frac{1}{2}$ feet long, wound with wire three-sixteenths of an inch thick, and turning between the poles of three large electro-magnets wound with the same wire. The resistance of each of the electro-magnets is 0·19 units, and of the rotating bobbin 0·21 mercury units. The commutator which receives the alternate currents is formed of 36 thin steel springs on each side of the arbour, cut in an incline so as to prevent their contracts all breaking circuit at the same instant. This apparatus could unfortunately not be shown in action in the Exhibition, on account of the axle having been bent by an accident during the transport from Berlin to Paris. In Berlin it was tried with a small steam engine, and when the armature was rotated at a velocity of 300 times in a minute, it gave a brilliant light between carbon points, decomposed two cubic centimetres of hydrogen gas per second, and rendered a length of three feet of fine platinum wire incandescent.

A second and smaller apparatus on the same principle is shown by Messrs. Siemens and Halske, intended for exploding mines. The armature is wound with thin copper wire covered with silk, the resistance of the coil being about 16 units. On the axis is a pinion which engages with the teeth of a cog-wheel of 26 times its diameter. The handle is fixed upon the axis of the wheel, so that, in turning it with moderate speed, a velocity of 50 revolutions, or 100 magnetic changes, is imparted to the armature per second. The armature turns between the poles of an electro-magnet, whose wire coil has a total resistance of about 35 mercury units. The apparatus is provided with a commutator by which the coils and armature are connected together alone sufficiently long to allow the magnetism of the cores to attain its maximum; the circuit is then opened automatically, and the fuze circuit inserted. Thus arranged, the apparatus is capable of exploding six fuzes at once. Of course the magnetism which was at its maximum on opening, or rather

lengthening the circuit, falls quickly; but the natural magnetic inertia of the soft iron cores prevents its immediate demagnetisation, and allows the armature time to develope a series of considerable currents. Mr. Sabine on Telegraphy.

The third apparatus shown is that of Mr. Ladd. This apparatus consists of a pair of soft iron plates placed horizontally one over the other, and wound with a quantity of thick insulated copper wire. Between their free ends turn two similar Siemens' barrel armatures, coiled also with thick wire. One of these armatures is connected through its commutator with the coils upon the two horizontal plates, the other with the carbon points, or other apparatus by which the dynamo-electric effects are demonstrated. Thus, in turning, the first armature polarized by the small quantity of residuary magnetism in the soft iron cores, induces currents in its wire coil, and these circulating always in the same direction around the electro-magnet, augment its magnetism, step by step, until it reaches its maximum. The other armature rotates independently, electrically speaking, of this part of the system, and induces currents in its coil which, passing over the carbon points, produce the light.

Up to the present moment, these machines, even with the valuable modification of two rotating bobbins, have not advanced beyond the importance of experimental apparatus. The reason for this is to be found, perhaps, in the expenditure of the mechanical force employed to drive them, in the production of heat, electricity, and magnetism in channels which are unprofitable, in so far as the apparatus is concerned. Thus in rotating independently of friction, the armature becomes considerably heated, and as the equivalent of heat is very high, a correspondingly great loss of electric current must be the result. In addition to this, magneto-electric currents are induced in the iron armature itself by its position to the poles of the electro-magnet, by its position to its own wire-coil in which currents are circulating, and by its own changing polarity. All these causes result in a diminution of the current generated in the wire, and an augmentation of the heat generated in the iron.

More perfect constructions will, however, in all probability, obviate these drawbacks, and produce a perfect apparatus for the production of electric currents from direct motion without permanent magnets.

### *Electricity as an adjunct of War Materials.*

The Austrian exhibition in the Galerie des Machines contains the most applications of electricity to the purposes of war. War telegraphs.

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The objects exhibited consist principally of torpedoes, and the apparatus for firing them. Their methods of telegraphing contain little which is either new or interesting. A full-size torpedo in a cylindrical wrought-iron case, with self-making contact studs around the top, forms an object of considerable interest amongst the numerous other articles shown in this department.

The torpedo in question consists of a cylinder of iron about 2′ diameter, and 3′ high, to contain nearly 168 lbs. of fine powder. This cylinder is contained in an outer casing 4′ high and about 4′ diameter, made air-tight, and the space between them left hollow, so that the specific gravity of the whole system is considerably less than that of water. On the top of the outer case, around the periphery, is a series of heavy studs on horizontal shafts protruding six inches from the side. These studs and shafts are held by stout spiral springs in a position of rest, and can only be pushed inwards on the application of a considerable force. Each of the shafts, which runs in guides, terminates obliquely before one of the teeth of a large sort of ratchet wheel having as many teeth as there are studs around the torpedo. When any one of the studs is pressed in, its shaft pushing obliquely against the wheel turns it slightly round on its axis, and this axis, being continued through an india-rubber stuffing box to the electric contact leading to the fuzes in the inner chamber, one of the contacts required for firing the torpedo is given. It is intended to fire these mines with double contacts; that is to say, that the hull of a ship striking the sunken torpedo makes one contact, and the other, or definite contact with the source of electricity, is made on shore at the observing station. The connection between the Austrian torpedoes and shore is made with lengths of Siemens' copper-covered cable—a piece of which is shown by the Ministry of War. The torpedoes are intended to be sunk about 12 feet below low-water mark, and their bearings, when being placed, to be taken carefully by means of a stadiometer, which may be arranged to give automatically the contact with the electrical apparatus as the observer turns the index, in following the ship with the telescope. The fuzes used for exploding these mines are made much like those of Professor Abel, with this difference, that the Austrians add a little graphite to their explosive compound (chlorate of potassium and sulphuret of antimony), for the purpose of making it conduct better, and of giving the fuzes a more constant resistance.

The appliances for firing these fuzes are: (1), by frictional electricity, and (2), by magneto-electricity. Five apparatus for

the production of frictional electricity for firing these mines are shown, all differing in their appointments. Two of these, a large one and a small one, are constructed with circular glass plates, the larger of the two having double plates of 60 centimetres diameter, and a leyden jar 4 feet high, and 9 inches diameter, capable of giving a spark 5 inches long. The three other electric machines are constructed with vulcanite plates. One of these is very conveniently fitted up in a case containing all the necessary accessories. The exciter consists of double plates of vulcanite 26 centimetres in diameter, and a condenser made of india-rubber sheet and tin-foil. In this form, which is very portable, it has been introduced into the service of the Austrian Engineers Corps, and forms part of the regular equipment. Each company of engineers is provided with such a case, containing, besides the electric machine, a drum holding 3,000 feet of gutta-percha covered wire, 200 fuzes, and all the tools necessary for working the machine, and for establishing the communication. These machines have, however, a great drawback to contend with in being subject to a great extent to the state of the atmosphere, and are therefore compelled in frequent instances to give place to the magneto-electric apparatus Five specimens of such apparatus are shown, all being on the same principle, and differing only in size. The largest of them is able to fire 15 fuzes at once. These apparatus are made and supplied to the Austrian Government by Mr. Marcus of Vienna. We were not able to see the interiors of any of them, nor were they explained to us; but we believe them to consist of a single angular-shaped flat horse-shoe magnet, with a bobbin coiled with a great length of very fine copper wire, moving between the horns of the magnet through a small angle as in Siemens and Halske's magnet keys, with the difference that the bobbin is in the latter placed across the poles, whereas in Mr. Marcus's apparatus it is placed between the horns longways. By means of a spring and catch, the armature is held against one side of the magnet until released, when it springs back suddenly and changes its polarity. The permanent magnet forms the two sides and bottom of a tall four-sided box, whose two remaining sides are made of plates of vulcanite, and the top, through which the axis of the bobbin protrudes, is furnished with the spring and releaser.

The Secretary of War (London) shows amongst the numerous war apparatus in one of the English annexes a length of Mr. Hooper's cable, and an apparatus invented by Professor Wheatstone for exploding mines. This consists

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of a magneto-electric machine resembling in construction that used in the transmitter of his universal telegraph instrument, the bobbins, are, however, larger, and the magnets both larger and stronger. On the top of the wooden case containing the machine is a series of buttons and a corresponding series of terminal screws to which the ends of the lines leading to the torpedoes are attached. By turning the handle and pressing either one of the buttons the corresponding mine is sprung.

### *Electricity as a Motive-power.*

Electro-magnetic machines.

The first proposition for the use of electro-magnetism, as a means of producing a useful motor for mechanical purposes, was made by Professor Henry, an American, in 1831. After him, and improving upon his construction, which was somewhat clumsy, came Sturgeon, M. Jacobi, of St. Petersburg, brother of the celebrated mathematician of that name, and a host of others. All their constructions are based upon the same principle, namely, the magnetisation of a piece of soft iron and its consequent attraction either to the pole of a permanent magnet or to another piece of soft iron magnetised by the same current. None of them have, however, succeeded in obtaining employment, and the reason of this is probably that both the development and disappearance of the temporary magnetism in the cores develop in their turn currents of induction in the wire which weaken considerably the magnetising power of the original galvanic currents. So great is this force of the opposing currents, indeed, that it is found on turning magneto-electric machines backwards, that the force of the electro-magnet is considerably augmented, and the same phenomenon comes to bear in explanation of the beautiful system, invented lately by Siemens, for the conversion of mechanical force into electric current, with the aid solely of the residuary magnetism in the cores.

Notwithstanding this, inventors are not wanting who still bring their apparatus and propositions before the public for the utilization of the galvanic current for the production of mechanical motion.

Amongst these, one of the neatest things is that of the Abbé Poitevins. The machine is arranged with a horizontal fly wheel, supported in the top of a vertical shaft whose lower end is supplied with a crank. Around the apparatus are arranged 24 single core electro-magnets placed radially and horizontally, before which are as many soft iron arma-

tures hinged above on the framework of the apparatus. The armatures are connected by means of rods with the crank, to which they give motion. The electrical contacts between the battery and coils of the electro-magnets is given by a series of studs in the periphery of a disc rotating on the central shaft. In order to prevent any resistance of the soft iron armatures in falling off by reason of residuary magnetism in the cores, l'Abbé Poitevins winds the upper part of each armature with a little wire, allowing a weak current to circulate in it opposite to that magnetising the cores, and by which he imparts to the armature a small but sufficient polarization to create a repulsion between it and the pole as soon as the contact with the driving battery is interrupted.

A new construction of electro-motor is shown by M. Kravogel of Innsbruck, in which a hollow heavy wrought-iron wheel is rotated by means of a permanent magnet creeping up inside it. In principle the apparatus resembles exactly a treadmill. Inside the outer case of iron in the centre of the section is a circular tube of brass, and in the annular space between the two tubes three coils of insulated wire are wound at right angles to the tangents of the periphery and connected with contacts properly placed at the axis. Inside the interior brass tube or ring is a magnet carried on anti-friction wheels, and occupying, perhaps, one-third of the whole circle. When a current is sent through the wire surrounding the magnet, the latter is deflected or creeps up the ring on one side or the other according to the direction of the current, and by doing so displaces the centre of gravity of the whole system towards that side. In consequence the wheel must turn slightly on its axis to compensate this displacement. But whilst it does so the magnet creeps up still further, so that the wheel acquires a continuous rotatory motion. There is very little friction in this machine, and it is probably one of those in which the equivalent of mechanical force, gained by an expenditure of an unit of current, would be found the highest. This is not saying much, however, for in the best constructed machine this found value must fall far short of the theoretical equivalent.

A company styling itself "The Electro-magnetic Com-"pany," having its head-quarters in Birmingham, shows two electro-magnetic engines, invented and patented by Mr. S. Moore. These engines are constructed of large cylindrical electro-magnets, whose armatures are carried loosely upon the connecting rods which convey movement to the

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crank. In the larger of these two machines are eight cylindrical electro-magnetic cores, each about five inches in diameter, placed four on each side, two above and two below. The armatures pull the connecting rods down, and when they have reached the poles allow the rods to fall through them and the fly wheel to turn the shaft far enough to interrupt the circuit. In the up stroke, which is done by the opposite magnets, the separation of the armature from the poles is easy because the core has had time to get rid of most of its residuary magnetism.

Like all other electro-magnetic machines this one has the destiny of superseding the steam engine, at least in the belief of its inventor. From experiments made at Birmingham, where fuel is very cheap, it has been found, we are told by the prospectus, that in employing a machine of this kind the cost would be only 25 per cent. more than the cost of steam power. However, the power of the steam engine, with which the comparison was calculated, is not stated, and therefore we may apprehend that it was a very small one. The Electro-magnetic Company assert further that in neighbourhoods where fuel is dear, the expense of employing one of their machines would be equal only to that of a steam engine. When this equality in the working expenses is found, fuel would be, the writer apprehends, so dear as to preclude the possibility of carrying on any manufacture whatever in which heat could be employed. We think that steam will not be so easily superseded by galvanism, but that the reverse is more likely to be the case.

### *Other applications of Electricity.*

Electric piano.

Besides the application of electricity to the arts of galvanoplastic, or reproduction by galvanism, etching, and the like, one of the most beautiful applications of the galvanic current which we have met with is the electric piano invented by Mr. Hipp, the ingenious director of the Swiss Telegraphs. This highly beautiful instrument is of an exceedingly simple construction. Each of the levers of the piano upon which the hammers are affixed is connected, by means of a light wooden arm, with the armature of an electro-magnet. The coils of the electro-magnets are connected with wires which lead to the instrument used to transmit the currents. The latter consists of a clockwork which draws a sheet of tracing cloth, perforated with holes to suit the time and notes, between a series of as many brass levers as there are keys of the piano, and a

metallic barrel. We have witnessed the performance of this ingenious apparatus with real pleasure. It is far from complete in all its arrangements, and especially in the perforated tracing cloth, which has hitherto been prepared by hand; when, however, Mr. Hipp has overcome this, as well as some other minor difficulties, his electrical piano will not fail to find very general favour. Mr. Sabine on Telegraphy.

Messrs. Kitson and Co., of Leeds, show one of Baker's new electrical anti-incrustators. The purpose of applying this apparatus to a boiler is, as its name implies, to prevent the deposit of solid matter upon the interior surface. Anti-incrustator.

The anti-incrustator consists of an arrangement of metallic points fixed in a boiler, in such a position that it collects the electricity carried by the out-going steam. In a word, the application of this apparatus converts a boiler into a sort of hydro-electrical machine. In Mr. Baker's form, a star of metallic points is supported in an insulating collar, and connected electrically with the plates of the boiler by means of a copper wire. When the steam is passing by the star, the latter becomes electrified, and communicates its electricity, through the copper wire, to the boiler. It is probable that the water is charged, at the same time, with a similar amount of the opposite kind of electricity.*

Now there are two different things to be accounted for: 1st, that if the boiler is new, it receives no incrustation; and, 2nd, that if it is an old one, and even thickly incrustated, the incrustation breaks up and falls to the bottom.

The first may, perhaps, be accounted for in two ways. According to Jürgensen's experiments,† particles of solid matter suspended in badly conducting fluids, which are under the influence of an electric current, move bodily from one pole in the direction of the other. Supposing now a current to be established between the metal of the boiler and the water, through the steam, which, in its formation, may carry off sufficient of one kind of electricity to leave the water charged with the other kind, the suspended particles might have a tendency to go from all sides of the boiler towards the centre. The other explanation is, that the suspended particles, the instant they touch the sides of the boiler, become charged with the same kind of electricity, and are therefore repelled from it. Theory.

The second phenomenon, that of the breaking up of an old incrustation, is more complicated. When the inner sur- Removal of incrustation by formation of steam

* Engineer, vol. xxiv. p. 483.

† Jürgensen, Archiv. für Anatomie, etc., 1860, p. 673.

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face of an ordinary boiler is covered with a thick deposit which is heat-insulating, the interior of the latter becomes the virtual boiling surface, whilst the boiler plates become superheated and very quickly burn away. As soon, however, as the electrical anti-incrustator comes into play, the water and the metal parts take opposite electricities, which are able to attain a comparatively high tension, because the incrustation acts as a dielectric. It would seem that, under these circumstances, a phenomenon of repulsion,* which is familiar to every student of static electricity, steps in. The phenomenon in question is that of the emission of water from a bucket through a capillary tube, or out of a sponge, as soon as it is brought into connexion with the prime conductor of an electrical machine.

When the water in the boiler is electrified, it is probably able to percolate through the pores of the incrustation, just as it does through a capillary tube in running out of the bucket, which it was unable to do when in an unelectrified condition. Forcing their way through the deposit, the water particles, attracted perhaps in the same direction by their opposite electrical state, approach the superheated surface of the boiler, *where they are converted suddenly into steam*, and in expanding burst up the incrustation. According to this view, electricity plays but an indirect *rôle* in the affair—that of facilitating only the percolation of the water through the incrustation, on the under side of which it explodes in its *formation into steam.* In the prevention of further incrustation, however, it is probable that electricity comes more directly into action, in causing, as said before, the solid particles to be repelled from the boiler surface by similar electrification, as soon as they make contact with it, or by the law which causes a definite motion to be imparted to particles of solid matter suspended in a badly conducting fluid through which a current of electricity is passing.

Another theory of the action of this apparatus has been given, which accounts for the removal of old incrustation by decomposition of water and salts underneath. The theory is, however, untenable from the fact that the quantity of electricity developed being very little and the surface of the boiler very large, the current in each point is exceedingly small.

### *Pneumatic Telegraphy.*

Air telegraphs.

There are two different methods shown for the transmisson of written messages short distances by means of a current

* Lardner, Electricity, p. 64.

of air: 1, the French system, shown by the Administration of Telegraphs; and, 2, the Prussian system, shown by Messrs. Siemens and Halske, of Berlin. In order that our readers may properly understand these systems, and also in justice to the English system, which is the original, we will glance cursorily at the development of pneumatic telegraphs.

English system.

The first telegraph of this kind was proposed in 1852, by Mr. Latimer Clark, and carried out in 1853, between the Electric and International Company's stations at Lothbury and the Stock Exchange. The line consisted of a lead tube of small diameter attached in the cellar of the central station at Lothbury to a vessel from which, by means of a pump, the air was exhausted. The messages from the Stock Exchange were packed into small cylindrical boxes made of felt, and put into the end of the tube. The valve being opened, the superior pressure of the air behind the box or piston forced it through, and it was received by a convenient arrangement at Lothbury. The success of the system induced the directors of the company to extend it to other stations, and to modify the apparatus by the introduction of pressure as well as vacuum reservoirs, enabling the transmission as well as reception of despatches by the central station.

Prussian system.

The system adopted in Berlin contains nothing new in principle, being an improvement in details only upon the English system. A well executed drawing of this system is shown by Messrs. Siemens and Halske, of Berlin, who designed and carried out the works for the Prussian Telegraph Direction. The tubes are of iron, $2\frac{1}{2}$ inches diameter, and extend between the Exchange and the central telegraph station in Berlin, being buried two to three feet feet below the surface. These tubes are parallel, one being destined for the reception, the other for the transmission of messages. At the central station the tubes end in two reservoirs, between which a pump, worked by a steam engine, exhausts continually the air from one and compresses it into the other. Thus the two tubes which are joined at the further station form a complete system, in which the air circulates uninterruptedly. At the central station each of the tubes is provided with a shifting arrangement by which the carriages containing the written messages can be introduced into the one and arrested and received by the other tube. At the further station in the Exchange is introduced an apparatus, shown in fig. 19, between the two ends of the tubes, and which has to fulfil the functions of both receiver and transmitter.

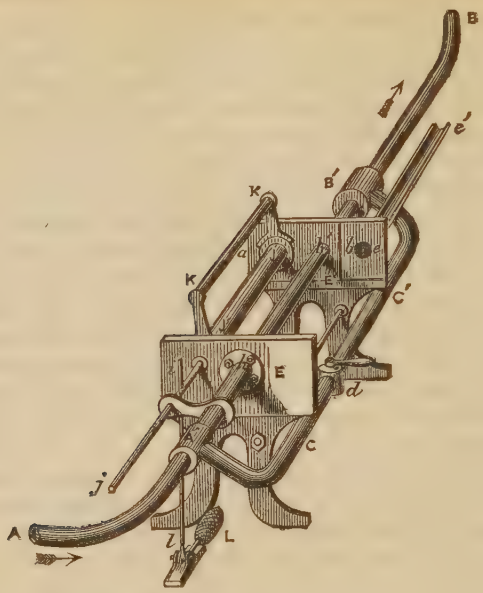


Fig. 19.

The two tubes, A and B, terminate in flanges bolted air-tight against the outside faces of the stands E and E′ respectively. At distance of a foot or so from the flanges, the tubes are perforated with a great number of holes and then covered by jackets, A′ and B′, between which is a connecting tube, C, C′, with a tap in *d*, the middle of it. The side, E′, of the stand is perforated with three equidistant holes of the same diameter as that of the tubes. Before these holes moves a slide broad enough to cover always two of the holes. The slide is composed of two parallel plates, of which that on the side of E′ is shown, in *a*, *b*, moving in horizontal guides, and connected rigidly by the tube *h*, *h′*, and the reception box J, J′, with a similar plate on the inner side of E. The trough *e*, *e′*, is composed of a portion of the line tube, the upper side of it being cut away in order that the carriages may be laid in for transmission. The lever system, *l*, *l′*, worked by the treadle L, is intended for forcing a plunger through the reception box in order to remove the carriages by the hole, J, on the further side of the stand. The air moves through the tubes in the direction shown by the arrows. When a carriage is to be sent off the slide system, J, J, *h*, *h′*, *a*, *b*, is drawn to the stop on the right-hand side, so that the tube *h*, *h′*, forms a continuation of the trough *e*, *e′*, and the reception box, J, J′, the continuation of the tube system, A, A′, B′, B. The

carriage is then pushed from the trough *e*, *e'*, into the tube, *h*, *h'*, the slide system is returned into its place as shown in the drawing, and the current of air taking the carriage, propels it along in the direction of the arrows, through the tube, B, to the other station. When a carriage is to be received, the slide system is drawn to the right hand, putting thereby the reception box, J, J', before the mouth of the tube A, as before. This box is lined with a system of brushes formed by stiff bristles, by which the carriage, arriving by the tube, A, is arrested, and prevented entering the mouth of the tube, B, by a stop worked by the handle *k*, *k*. As soon as the carriage has arrived, the slide system is returned to its normal position, and by treading upon the plunger lever, L, the carriage is forced through the opening at the other side of E'. In case this apparatus is to be used as an intermediate station through which a carriage is to pass without being arrested, the slide system must be left in the position shown in the figure, by which the tube, *h*, *h'*, forms a completion of the system, A, A', *h*, *h'*, B', B, and the carriages can be carried through without interruption. The tap, *d*, is provided for allowing the air to pass through the shuntway, A', C, C', B', during the changes of the position of the slide system or during any operations which may be found necessary with the stand or slide.

An extension of this system is about to be carried out in Berlin between the central station and post office, in which tubes of three inches diameter will be employed. It is not yet decided what form of carriage will be definitely adopted. In the present system the carriages are formed of cylindrical boxes supported upon four wheels, two before and two behind, placed at right angles to each other. For cleaning the tubes, carriages with brush-formed ends have been employed, which appear not to occupy more time in their transit than the carriages carried upon wheels, probably on account of their better fitting the tubes and therefore allowing less slip of air at the sides, and are free from the danger attending the breakage of the wheels or the axles. It is therefore probable that in the extension only brush carriages will be used, which, being considerably shorter, will allow of the line to take shorter curves, a point of some importance in laying down the tubes in the streets of a city so thickly built over as Berlin.

French system.

In the system exhibited by the Administration of Telegraphs of France, and of which a length of 11 kilometers has been laid down in Paris, the steam power used in the English and German systems is dispensed with, and only the pressure of the water supply of the town used. The French system was designed by Mr. Baron, Inspector-General of French Tele-

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graph Lines, and the works were carried out by Messrs. Mignon and Rouart. The Paris pneumatic telegraph is placed in a complete circuit between the principal collecting stations of the city—the Exchange, the Grande and the Louvre Hotels, the telegraph station in the Rue Boissy-d'Anglas, the post office, and other points of considerable traffic. Each station is supplied with a large reservoir, which is connected, by means of a large tap, with the pipes leading to the town water supply, with exhausts by which it can be emptied at pleasure, and with two smaller reservoirs for receiving the air compressed in the larger one. When the air of the latter is being compressed by the admission of water, the valve connecting it with one of the smaller or air reservoirs is opened and the compressed air allowed to enter it. The valve is then closed, the water allowed to run out, and the other air reservoir filled in the same way. The reception and transmitting apparatus shown in fig. 20 is connected through the pipe B with a branch pipe by which the compressed air from either of the reservoirs can be blown off through it. This apparatus consists of a cast-iron stand, DD′, surmounted by an air-tight box, in front of which is the lid or door, *a*, opened by the handle, *d*. The tubes A′ and B′ enter from opposite sides, and the tube, *b*, leading thence to the next station. The tube B, which leads to the pressure reservoirs, is connected, through the valve *c′* with B′, whilst the other opening, A′, of the box is connected through the valve, *c*, with the open tube, A. These valves are worked together by a common shaft with two endless screws which gear into the teeth of two segments of cog-wheels on the axes of the valves, in such a way that, when one of them is open the other is closed. A central vertical tube, EE, closed at the top above the reception box, is used only when the carriers arrive to act as a cushion of air, against which they expend

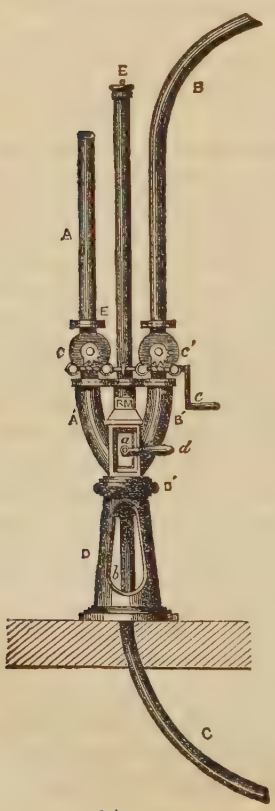


Fig. 20.

their force. When the carriers arrive the valve *c* is opened, and *c'* closed, allowing the air forced before the arriving carriers to escape out of the pipe, A. The operator waits in front of the apparatus, the door, *a*, being opened, and, as soon as he hears the carriers shoot up into the tube EE, inserts a kind of fork into the box, which is constructed to catch them as they fall back, and prevent them re-entering the tube *b*. In sending off the carriers they are dropped into the tube, *b*, through the door, *a*, which is then closed, the valve *c* is closed and *c'* opened, allowing the air compressed in one of the reservoirs to enter the tube.

The system may be worked up to two atmospheres pressure, the air is, however, seldom compressed beyond half an atmosphere above ordinary atmospheric pressure. The volume of each of the cylinders is double that of the tube reaching to the next station, so that supposing no loss to take place under way, the pressure of air in the transmitting cylinder is only reduced about a quarter of an atmosphere.

Each station is supplied with two receiving and transmitting apparatus, as shown in the figure, one for each of the tubes which enter from different directions. In this way messages can be received or despatched at pleasure in either direction. The working cost of this system, which would appear at first sight to be rather great on account of the enormous volume of water expended, is in reality less, on these especial lines, than it would be were steam power employed. The carriers are made of leather in a convenient form for being shot through the tubes. Each carrier is constructed to contain 40 separate messages; and on the more busy parts of the line, as, for instance, between the Exchange and central station during business hours, on an average, trains of ten carriers are despatched at once. The cost of water averages 25 centimes per kilometer distance, per train; and therefore, as each train contains 400 dispatches, and the average distance between the stations is one kilometer, the cost per message amounts to $\frac{1}{160}$ part of a centime, or the $\frac{1}{1600}$ part of a penny.

### *Optical Telegraphs.*

Optical telegraphs.

Semaphore telegraphs do not hold a very conspicuous place at the present day amongst the systems in use. They are nevertheless not only useful but sometimes necessary, for instance at sea and in war, when the erection and maintenance of an electric telegraph wire would be impossible.

Austrian system.

The system of signals in use by the Austrian Corps de Genie is very simply and completely arranged, and is preferred in the fortifications in Austria by reason of its cheap-

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ness and freedom from getting out of order. The three signals are placed at a sufficient height, two being horizontal, and the remaining one above them, so as to form the three corners of a triangle. The alphabet is formed of different positions of these signals. By day their coloured discs are used, and by night their lamps. The size of this telegraph depends upon the distance it is intended to carry. The observations are made with a telescope from any convenient shelter near the post.

American system.

The American system, shown by Mr. Ward of Pennsylvania, differs from this in the *order of succession* of three signals, instead of their *position* being taken as the basis for the construction of the alphabet, &c.

Ward's signals are composed of three elements: either three colours, three different sounds, as a bell, a horn, and a whistle, or either of them sounded once, twice, or thrice, to answer to the three elements, or three marks of any kind. For marine purposes at night, Mr. Ward has constructed three lamps, one suspended over the other, surrounded respectively with green, red, and white glass. These lamps are provided with moveable shutters suspended upon spiral springs, which, by means of a cord, may be drawn down to expose the lamps when the system is hoisted to the masthead. With this arrangement, it is evident that either of the lamps may be used singly, or signals given consisting each of two, three, or more repetitions of the same elementary sign, or they may be varied with the others. The number of variations which are possible with this system are obviously as follows:—

| | | |
|---|---|---|
| With one sign each | ... ... | $3 = 3$ |
| With two signs each | ... ... | $3^2 = 9$ |
| With three signs each | ... ... | $3^3 = 27$ |
| With four signs each | ... ... | $3^4 = 81$ |

In all, therefore, 120 variations are possible with these elements, and with from one to four signs. For convenience of reference, Mr. Ward has constructed a diagram which gives at a glance the letter or number referred to by every signal included in these four repetitions. The diagram consists of four concentric circles described around a centre and divided into three equal angles by radiating lines. The three spaces of the inner circle are painted respectively green, red, and white. Each of the three spaces forming the second circle is divided again by lines radiating to the periphery of the outermost circle into three equal spaces, painted each in the same order, and marked with the numbers 1 to 9. The third circle is divided into 27 equal spaces, in succession, green, red, and white, marked with

the alphabet. When a signal is received, the operator refers to his table, noting the succession and number of elements, and commencing from the centre follows the circle outwards in the order of colours in which the signal was given. The point where he ends is the signal transmitted.

It would, no doubt, be possible to employ these three elements as the dot, dash, and space of the Morse alphabet, by which the correspondence could be carried on in ordinary language, and thus save the necessity of a code to interpret the signals.

## Report on Civil Engineering, Public Works, and Architecture.—(Class 65.)—By Captain Ponsonby Cox, R.E.



Although there is no science which has given to the world such important practical results within the last few years as that of civil engineering, and though there is probably none which has made more real scientific progress, its recent progress and its later results are far from being adequately represented in the Exhibition of 1867. Inadequate representation of Civil Engineering.

In the French section, only, is there a satisfactory exhibition in civil engineering proper; the other European nations, as well as the United States of America, are but slightly represented. Our own country can hardly be said to be represented at all.

This is much to be regretted, for undoubtedly a well-assorted collection of models or drawings of the most important engineering works scattered all over the world, which are due to the energy and skill displayed by English engineers within the last few years, would, if placed side by side with the magnificent collection of models and plans in the French section, have formed an exhibition most interesting and instructive, would have added much to the available knowledge of civil engineering of the world, and saved much of the labour thrown away in re-inventing. From this point of view the Paris Exhibition cannot but be looked upon as a great opportunity lost. The public works of London alone might have supplied admirable examples in the great railway stations and river bridges recently constructed, as well as the works connected with the main drainage and the Thames embankment. The materials for a good display exist no doubt in the works of Great Britain and her colonies, but we do not possess (nor does any other nation possess), for tabulating those materials, such a machinery as France has in her establishment "des Ponts et Chaussées," her "Ecole des Mines," "des Arts et Métiers," &c.

The French collection is unrivalled; it contains models, admirably got up, of bridges, viaducts, reservoirs, docks, tunnels, &c., with complete plans illustrative of all recent public works. A brief but clear report of each work is to be found in a volume published under the auspices of the Ministère d'Agriculture, du Commerce, et des Travaux France.

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Publics. From this source have been derived the figures which will be found in the short notice of some of the most important public works attached to this memorandum.

England.

Leaving France for the present, we find the most important exhibit connected with civil engineering in the English section to be the application to lighthouses of the dioptric system of light of Augustin Fresnel, which system is now being generally introduced, both for fixed and revolving lights. The Trinity House and the Commission of Northern Lights have sent a series of models of lighthouses, lightships, &c., and several lanterns of different sorts and sizes. These lanterns are all from the works of Messrs. Chance, of Birmingham, and comprise the improvements made by them as well as by Mr. Douglas for the Trinity House, and Messrs. Stevenson for the northern lights. The dioptric system has been recently admirably described by Mr. Chance in a paper read at the Institution of Civil Engineers. It consists of a structure of segments of glass enveloping a central flame whose focal rays are parallelized in a horizontal direction and deflected, in the case of fixed lights, in meridian planes only, whilst in revolving lights the rays are gathered into a number of cylindrical beams, which are made to pass successively before the observer by the rotation of the apparatus. The dioptric instrument is further described to consist of three main divisions; an equatorial belt of the sphere of light proceeding from the flame is acted upon by refraction, but the rays above and below this belt are deflected by total reflection; the relative illuminating values in the horizontal plane of these divisions of the part of the luminous sphere acted upon are in the proportion of, upper reflectors, 20; refracting portion, 70; lower reflectors, 10.

Dioptric system.

Magneto-electric light.

It is most important to send towards the sea horizon the brightest sections of the flame. The Trinity House Corporation exhibits the application of the magneto-electric light, for the discovery of which the world is indebted to Professors Faraday and Holmes. The former discovered in 1831 that a spark could be produced by magneto-electricity; the latter, that by this means a continuous flame could be kept up. In 1857 the discovery of Professor Holmes was first applied in the South Forelard lighthouse. It has since that date been submitted to long practical trial, the result of which has been the determination to adopt it in other lighthouse stations.

The machine for the production of the light consists essentially of six brass wheels, with 16 bobbins of insulated copper attached at equal distances to the circumferences of each wheel; inside each bobbin is a hollow core of soft iron;

the wheels are all fixed upon a shaft, which is driven by a steam-engine. In turning, every core of each wheel is brought at the same instant between the opposite poles of two magnets, which pair of poles is also quits at the same instant. The core of every bobbin has its magnetism thus reversed by the revolution of the wheels 107 times per second. This reversing of the magnetism induces a current of electricity in the bobbins; the combination of the currents produces one of sufficient intensity to give a powerful light. The lantern in which the electric light is used was designed by Messrs. Chance, by whose arrangement the bars of the lanterns are fixed obliquely, and by this means the amount of light stopped by the lantern is reduced to a minimum.

Enamelled ceiling, tiles, and terra-cotta.

The above appear to be the most striking exhibits in the English section; and, indeed, there is little else calling for special notice in engineering, properly so called. Mr. H. Cole has sent a specimen of enamelled ceiling, which in many cases might be adopted with advantage, and the exhibits of ornamental tiles by Minton and Mawe, and of terra-cotta by Blanchard, Blasfield, and Pulham are prominent instances of improvement in materials of construction.

Messrs. G. Smith and Co. exhibit a specimen of the façade of the South Kensington Museum, showing an admirable combination of finished brickwork with terra-cotta mouldings and enrichments.

Belgium. Boucqueau's system of tunnelling.

Turning to Belgium, we find in an annexe a model of the system adopted by M. E. Boucqueau in the construction of a tunnel on the line of railway from Brain le Conte to Gand. The tunnel, which is about 440 yards long, is carried through a hill on the bank of the river Dendre. It is approached on the north side through a considerable cutting, and the line at the south side is carried on an embankment. It was necessary, in order that the work should proceed with rapidity, that the tunnel should be attacked at several points at once. Sinking shafts from the ground above and lifting the stuff over the hill would have been attended with considerable expense. M. Boucqueau consequently determined to drive in a small gallery, parallel to the tunnel, at one side of it and about 2 ft. below its general level. From this gallery adits were driven right and left at right angles to the axis of the tunnel. The whole of the *deblai* was taken out through these adits and disposed of at the south or embankment side of the hill, whilst the small gallery, being somewhat below the proposed level of the permanent way in the tunnel, kept the workings free from water. The gallery was 5 ft. wide by 6 ft. high. Its sides and ceiling were supported with sheet piling and lagging. The distance between the axes of

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the small gallery and the tunnel was 57 ft.; the branch adits were about 70 to 80 yards apart. A tramway was laid along the gallery, with turn-tables for the earth-waggons at the mouth of each adit. This system claims to have effected a considerable saving in time and money, as compared with the plan of sinking shafts from the top, but it is probably only of exceptional applicability, as in most cases the ordinary system of working from a heading within the line of the tunnel itself would be less expensive.

Prussia. System of centering.

Prussia exhibits a system of centering lately used in tunnelling, the essential feature of which is the substitution of a portable iron framework for the ordinary timber centering.

This system has been adopted in the construction of the tunnels of Narusen and Ippensen. A framework consisting of cast-iron segments bolted together supports a second iron framing, which latter is formed of railway metals, bent and fitted together with radiating joints, like the voussoirs of an arch. These two frames form the principals of the centering. The upper voussoirs are attached to the lower frame by clips, which overlap the lower flange of the railway metals of which they are formed. The voussoirs can be removed one by one as the masonry of the arch is brought up to replace them.

From the soffet of the iron principals are suspended hanging pieces, also of railway iron, which support cross bearers carrying tramroads in two or three tiers, as may be necessary, to remove the excavations and to supply the materials of construction.

The advantages claimed for the system are that, from the interior space being not hampered by uprights to carry the principals, as would be necessary if wood were used, the work can be carried on with much greater facility; it is easier to range out the line and to work truly, to ventilate the tunnel, and to get rid of water. The first cost is stated to be very little, if at all, above wooden centerings; and, from the greater durability of the materials, it is stated in the long run to be more economical. It is open, however, to the objection that unequal pressure of the surrounding earth, if sufficient to fracture the centering, would produce much more serious damage than with the ordinary systems in use. The design is by M. Franz Rziha.

South Germany. Railway bridge of boats.

In the southern States of Germany a remarkable example of cheap railway-bridge construction is exhibited in the Bavarian section, by a model, on a scale of 1-30th full size, of a bridge of boats over the Rhine, between Maximilians-au and Maxau, which carries a loop-line of the Carlsruhe and

Winden Railway Railway, opening up a considerable local traffic, and carrying the coal trade between Bavaria and Baden. The main line crosses the Rhine at the bridge of Kehl.

The road traffic at this point was formerly carried over a bridge of boats, situated about half a mile higher up the stream than the present one; this has since been removed, and the ordinary as well as the railway traffic crosses the new bridge.

The Rhine at Maxau is 240 metres wide; its bed, which is of gravel, is constantly influenced by the deposit brought down by the current, the navigable channel being thereby shifted alternately to the Bavarian and Baden bank. This cause has made it necessary to make two parts of the bridge, one on each side, moveable, to allow the passage of the river traffic. The bridge is at right angles to the stream; its length over all is 362·80 metres, of which 234 metres is actual bridge, the ramps of approach from each shore being 64·10 metres in length. These ramps are supported upon timber stages, and their gradient can be regulated by a system of screw gear to suit the level of the stream. The recorded readings of the Rhinometer at Maxau show the extreme range of variation of water level to be 5·10 metres —*i.e.*, between 3·60 above and 1·60 metres below the zero of the scale. These extremes have, however, been but rarely reached. The mean level of the Rhine is 2·50 metres on the scale, and this heighth of water gives an ascending gradient of 1 in 60 to the approaches to the bridge; the extreme reading of 3·60 metres on the scale giving a gradient of 1 in 30.

The bridge consists of 12 rafts, six of which are easily removeable to allow the passage of boats; these rafts are carried by 34 pontoons or boats, substantially bnilt of oak, of which material are also the principal beams and the upper planking of the roadway. These pontoons are 65 ft. 6 in. long, 12 ft. 2 in. broad, and 4 ft. 7 in. deep, except the two pair next the shore, which are somewhat larger.

In order to allow the permanent way to adapt itself to the rise and fall of the water level, as well as to the deflection of the roadway from the immersion of the pontoons, on first taking the weight of the train as it leaves terra firma, the joints of the longitudinals and the metals which they carry are made with a hinge where their shore end and bridge end abut, besides which these ends are each borne upon a strong coach-spring.

The general arrangement of the bridge, the position of

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the moveable rafts, and the method adopted of attaching the various parts to each other, will be readily understood.

This bridge was designed by M. Basler, engineer in chief of the railways of the Palatinate. The total cost of its construction was 12,000*l.*

Italy. The Mont Cenis tunnel.

In the Italian section is an atlas containing plans and sections of the great tunnel of Mont Cenis, which is being constructed, as is well known, to unite the Paris-Lyons and Mediterranean Railway with the Italian railways, so as to establish communication with an unbroken gauge between Calais and Brindisi, a distance of 1390 miles, and to annihilate the danger and difficulties of crossing the Alps; which will, however, be much reduced, long before the completion of the greater work, by Mr. Fell's summit railway. The entrance on the French side, about 1½ mile from Modane, is 439 feet lower than the Italian end at Bardonnèche; this would give a gradient in the whole length of the tunnel (7 miles 1,007 yards) of 1 in 91, nearly. The tunnel is not, however, being executed at a uniform gradient; a fall is given towards both ends from the centre of 1 in 2,000 and 1 in 45 respectively. The works, which were commenced in 1857, were first carried on by manual labour. During 1858, 844 ft. were thus driven at the Bardonnèche end; this was the greatest progress which has been made by manual labour in one year. The works are now being carried on with boring machinery driven by compressed air, motive power being obtained by water at the French side from the River Arc, at the Italian side from the River Mezelet, from which sources the water is led to reservoirs. Since the adoption of machinery, the progress has been much more rapid. In 1865 the length driven amounted to 2,502 ft. on the Italian side.

Commencing from the French end, the first 2,350 yards have been through schist; then 550 yards of quartz were encountered, through which the progress was very slow. This has been cut through, and the tunnel on the French side is now through limestone, which is not quite so difficult as the quartz. The present progress through the limestone is about one yard per day; through the quartz it hardly reached 2 ft. After passing the limestone, schist is again reached, which formation extends to the Italian end. It is now stated that the probable date at which the excavation will meet will be some time in 1873.

Government works.

The public works recently executed by the Italian Government are also shown in an atlas of plans; but they are

principally military barracks, and do not appear to be very important or to possess much general interest.

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The most important work of civil engineering shown by Spain is the breakwater of Tarragona, of which there is a sectional model.

Spain. Breakwater of Tarragona.

This work, which is still in progress, can lay claim to priority in point of age to any work of civil engineering in the Exhibition, its commencement dates as far back as 1790.

It is intended when finished to be about 1,500 yards long, with a total width at top of 100 yards, including a pier on the inner side of 65 yards wide. The base of the breakwater is nearly 300 yards wide; it is formed of pierre perdu. Some of the blocks in the base are of enormous size; their interstices are filled in with smaller blocks; the top stratum is of concrete up to the level of the pier. The work has been carried out principally by convict labour.

France. Models and plans of the Public Works Department.

It is in the French section, as has been already stated, that we find by far the most important exhibition of works of civil engineering. France undertakes to tell us what her engineers have been doing during the last few years; she shows immense progress in the science. A careful study of the admirable collection of models and plans exhibited by the Public Works department cannot fail to produce the conviction that the works they represent have been most scientifically designed, and executed with great care, great practical skill, and economy. A very slight description is given of a few of the most remarkable of these works. The first selected for notice is the great swing bridge of Brest, which spans the inlet of Penfield between the towns of Brest and Recouviance. Two models—one on a scale 1-50th full size of the whole bridge, another, 1-10th full size of one of the piers— exhibit the construction. This bridge has a greater span than any bridge of similar construction in the world; it is well and solidly constructed, and has stood the wear and tear of ten years without any considerable repair.

Swing-bridge of Brest.

The distance between the sea-face walls of the Penfield (571 ft.) is spanned by two wrought-iron lattice frames, revolving upon turntables which crown two circular towers, 34 ft. 9 in. in diameter and 347 ft. apart in the clear: the latter dimension is the total width of the fair way of this part of the naval harbour. Each of these two frames consists of two girders, 25 ft. 4 in. deep over the piers, and 4 ft. 7 in. deep at the centre; these are strongly braced together with perpendicular and diagonal braces, and support the roadway,

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which is itself constructed so as to add considerably to the rigidity of the structure.

The shore ends of the frames form a rectangular box, which contains the counterweights of the bridge. The total weight borne upon each pier is 590 tons; the turntable on the summit of each pier is 29 ft. 6 in. in diameter, and has fifty rollers, each 1 ft. 7 in. in diameter, and 1 ft. 11 in. in length. The means of opening and closing the bridge is extremely simple; it consists of a pinion fixed to the revolving part of the bridge, gearing into a horizontal cogwheel on the pier. The motion is transmitted by an intermediate to an upright shaft, which comes up through the roadway of the bridge, and is crowned with a capstan. Four men with capstan bars can open the bridge in ten minutes. Should it be necessary to repair or replace any of the trucks, or any other part of the mechanism of rotation, the whole weight of the bridge can be lifted off its bed by means of four hydraulic presses in the centre of the piers.

The foundations of the piers are on the solid rock. They are built of rubble masonry, faced with ashlar. The sea walls are of rubble, with dressed quoins; the weight of the metal used in the construction of the bridge is 1,180 tons.

The total cost, including foundations, was 85,000*l*.

The design was by M. Oudry; the works were carried out by MM. Schneider and Co., of Creusot.

Masonry arch.

A very remarkable exhibit by the Ministère des Travaux Publics is a model (1-25th full size) of a masonry arch designed and built by M. Vaudray, engineer of the "Ponts et Chaussées," as an experiment preliminary to the construction of a bridge over the Seine, to connect the Rue du Louvre and the Rue de Rennes. The bridge in question had to span the river exactly over the locks of the Canal de la Monnaie; and the necessity, on the one hand, of keeping the springing of the arch above the lock walls, and, on the other, of keeping the level of the roadway down to the existing level of the streets leading to it, confined the rise of the arch to a height not exceeding 7 ft., whilst its span had to be nearly 125 ft.

In order that the new bridge should be in keeping with the numerous important public buildings in its vicinity—viz., the Pont Neuf, the Louvre, the Hôtel de la Monnaie, &c., it was very much to be desired that it should be of stone; and, the possibility of building so flat an arch with the span required in that material having been questioned, it was determined, before carrying out the project, to build an experimental arch which should fulfil the required conditions.

The spot selected for the experiment was the quarry of the plains at Soupes, 60 miles from Paris, on the Bourbonnais Railway. The natural quarry face of the rock was shaped to form one abutment, the other was a massive block of masonry built for the purpose.

The description and general dimensions of the arch are as follow:—Its form is a segment of a circle, of which the chord is 124 ft., the versed sine 6 ft. 11 in. It is built entirely of cut stone; the number of the voussoirs in each ring is 77, diminishing in depth from 3 ft. 7 in. at the springing to 2 ft. 8 in. at the keystone; the beds and joints of the voussoirs are dressed with the greatest care, and are laid in Portland cement mortar, the composition of which is two parts sand to one part cement. The thickness allowed to the mortar joints was $\frac{2}{8}$ in. The joints next the skewback were not flushed until after the completion of the ring, having been meantime kept open with fir wedges.

The artificial abutment is 27 ft. in height, 49 ft. in mean thickness, and 12 ft. wide (this is also the width of the arch); it was built of rubble masonry, well bonded together and laid in Portland cement mortar—one part of cement to three parts of sand; its construction occupied 20 days, the laying of the voussoirs 17 days.

The arrangement for striking the centering was by the means of dry sand contained in iron cylinders, hereafter described. This method, it will be observed, is peculiarly well adapted for so critical an experiment as the one under notice. Arrangements were made to observe with the greatest exactitude the effect which should be produced on the arch by the removal of the centering. The arch was left to set four months; the centering was then eased by allowing the sand to flow regularly from the cylinders. In an hour daylight was perceptible between the soffit of the keystone and the lagging; in two hours the arch and the centering were quite separate. The result upon the arch was then found to be as follows:—

The crown had come down 6-10ths of an inch, the joints of the skewback had opened on the built abutment side 7-1000ths of an inch. After the lapse of three days the arch was observed to have come down 7 100ths of an inch more.

It was then loaded with a weight of 360 tons, disposed over the whole surface of the roadway; the loading occupied 13 days. When complete the crown was found to have come down 3-10ths of an inch.

Since then nothing has stirred. The arch was afterwards tested by a weight of five tons being allowed to fall on the

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roadway vertically over the keystone from a height of 1 ft. 6 in., but no joint has opened, nor has the bridge sustained the slightest injury.

This interesting experiment satisfactorily proves that the relative proportions of rise to span in large masonry arches to which engineers have hitherto limited themselves may be largely modified; it is quite clear, however, that such constructions require very accurate work and the greatest care in execution.

Method of easing and striking centering.

Allusion has been made above to a method of easing and striking centering by means of sand. A full-size model in the park shows this method, now frequently adopted by French engineers for easing large centerings from arches on completion of works, viz., by resting the principals of the centering upon sand contained in iron cylinders, from the bottom of which the sand is allowed slowly to escape.

Each principal is supported upon round props, fitting as a piston into a cylinder, containing fine *dry* sand.

The cylinders are of sheet iron, one thirty-second of an inch thick, one foot high, and one foot in diameter. About two inches from the bottom they are pierced with holes about three-quarters of an inch in diameter, which are stopped with common corks. To ease the centering the corks are removed; the sand then escapes through the holes, until a cone of sand is formed at the base of the cylinder. The formation of this cone arrests the further escape of the sand, and therefore the descent of the piston, until the cone is swept away, when it re-forms. The sweeping is repeated until the piston has descended sufficiently to detach the centering from the masonry.

By taking care to sweep away the same cones simultaneously, the lowering of the centering can be performed with perfect evenness, and as gradually as may be desired, by one-millionth of an inch, if necessary; whilst, as no force whatever is required to be used, the arch is not subjected to the slightest shock during the operation. This system was originated by M. Beaudemoulin, engineer in chief. It has been applied to many important works; amongst others, to the fine bridge of Austerlitz.

Models of iron railway viaducts.

Three fine examples of engineering are exhibited in models, 1-25th full size, of the three iron railway viaducts of Busseau d'Ahun, la Cere, and Du Midi; they are all three of the same type. One of them is the viaduct of Busseau d'Ahun, which carries the chemin de fer d'Orleans between Montluçon and Limoges across the river Creuse, close to the junction of Busseau d'Ahun.

It is composed of a lattice girder in six spans, supported upon iron columns, surmounted upon masonry bases.

Each of the five piers consists of eight hollow cast-iron columns, in two rows of four (transversely to the roadway), crossbraced horizontally and diagonally with rolled iron joists; these piers support four main lattice girders, connected by cross girders, bearing a timber floor and continuous sleepers.

The eight columns of each pier batter towards a point 148 ft. above the roadway, thus forming a four-sided truncated pyramid; the same batter is given to the masonry bases upon which they are mounted. This arrangement gives a very pleasing effect to the structure. The bases are rectangular blocks of ashlar, with dressed quoins carried up from the rock; the iron superstructure is secured to them by eight holding-down bolts of 3½ in. diameter round iron.

The work of erecting this viaduct was performed with great skill; the main girders were riveted together on the bank, and launched into place without the use of scaffolding; this was effected under the direction of M. Moreaux. The design of the viaduct is due to M. Nordling. Its total cost was 60,000*l.* sterling.

Iron lighthouse.

The fine and well-proportioned iron lighthouse in the park has been constructed by M. Rigolet, of Paris, from the design of M. Reynaud, Inspecteur-Général des Ponts et Chaussées. It is destined for the rocks called "Les Douvres," situated midway between the islands of Guernsey and Brehat, off the coast of Brittany.

The rock on which this lighthouse is to be built is in the middle of the south edge of the shoal; its summit is awash at high tide. The masonry foundations of the lighthouse are 6 ft. 10 in. high; the height of the iron column is, from base to floor of gallery, 158 ft. 6 in.; to top of lantern, 184 ft. 2 in. In plan it is a 16-sided polygon. The diameter of inscribed circle at base is 36 ft. 6 in.; at top, 13 ft. 2 in. The light is 174 ft. above high-water level.

Round the base of the column are the store-rooms and living-rooms of the lighthouse-keepers; above these are rooms for the reception of persons rescued from shipwreck. In the centre of the column is a cast-iron staircase from the base to the lantern.

The chief peculiarity of the construction of this lighthouse is that the structure depends for its strength wholly upon its skeleton; the iron plates which are attached to it are merely a skin, and are not at all relied upon for strength; whereas, in wrought-iron lighthouses of ordinary construction, strength is obtained by the riveting together of the plates of

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which it is composed. The reasons which M. Reynaud has given for this departure from usual construction are—1, that plate iron is liable to rapid decay from oxydisation; 2, the ordinary mode of construction necessitates special appliances and scaffolding, &c., not easy to erect upon a rock situated as is the Douvres, whereas he has been enabled to arrange the parts of his structure so that it can be put together on the site with great facility. The skeleton of the structure consists of 16 frames, forming the sides of the polygon, 15 panels high. Each panel is formed of $7\frac{3}{4}$ in. by $3\frac{3}{4}$ in. T iron. securely riveted together. These panels are bolted each over each, and strengthened at their edges by a binding piece of 7 in. by $3\frac{3}{4}$ in. T iron bent to the shape of the polygon. The skin is $\frac{3}{8}$ in. plate iron at the base, diminishing to $\frac{1}{4}$ in. at the summit of the column. The joints of the plates are overlapped with strips of $\frac{1}{2}$ in. iron. The balcony of the lantern is carried upon cast-iron cantilevers. The light is dioptric, revolving upon 10 steel friction rollers upon a hardened steel tread plate. The supply of oil is regulated by clockwork, manufactured by M. Lepaute, of Paris.

The weight of the lantern is about four tons. The total cost of construction was (including erection in the park and taking down hereafter), 10,000*l.* sterling.

Tunnel of Ivry.

The tunnel of Ivry, a model of which (1-25th full size) is exhibited, is chiefly remarkable for the skilful manner in which the difficulty of obtaining a secure foundation for the masonry of the tunnel has been overcome.

This tunnel carries the girdle railway of Paris beneath the Champ de Mars of Ivry; is 220 yards long. Its permanent way is about 40 feet beneath the surface of the ground. The formation through which it is driven is sand, above a marl bed, which overlies a stratum of calcareous stone, good for building purposes, and formerly much used in constructions in Paris. The quarrying of this stone has left considerable cavities beneath the site of the tunnel, and have necessitated the precautionary measures for securing its foundation shown in the model.

To carry down the side walls of the tunnel to the solid floor of the quarry, as first intended, would have involved immense expense, and as it was found that the stratum which intervened between the required level of the permanent way of the railway and the excavations beneath was of a solid nature, it was determined to shore it up from below with masonry walls, exactly beneath the site of the side walls of the tunnel, and to fill up the cavities between these lower foundation walls with rammed earth. To effect this, two galleries were driven beneath and parallel to the intended

tunnel; these were lined with masonry walls, so placed that one (the thicker of the two, and the nearest the axis of the tunnel) should coincide in plan with the side wall of the tunnel, and should support the stratum of rock upon which the latter should be built.

These minor galleries were arched in, and served as galleries of inspection, by means of which the foundations could be examined both during the progress of the work and after it had been tested by the passage of trains. Many difficulties occurred in the execution of the work, owing to the ground having been largely fissured by faults in the quarry veins. A serious obstacle was met with, owing to a part of the old quarry having caved in beneath the superincumbent earth. The earth which had slipped had assumed the form of a truncated cone of about 30 ft. in diameter at base, and 15 ft. at its upper surface. In order to carry the foundation gallery through this fault, it was necessary to support the whole circumference of the slip upon masonry carried up from the solid rock. This done, the whole of the loose *déblai* was removed through the gallery of inspection, and, piers being then built up at the extreme edge of the slip, an arch was thrown across the space, and the pier wall of the tunnel built upon it. It will be readily seen that this was a critical and difficult piece of work; it was carried on night and day in reliefs, under the direction of M. Bassompiere, engineer in chief des Ponts et Chaussées.

Syphons.

An extremely ingenious system of syphons recently applied in France to large reservoirs for the purpose of getting rid of the surplus and storm waters, is shown by two models, one of 1-40th full size, and another of the head of the syphon-feeder, 1-10th, full size.

The system presents some novelty, has been found to work well, and it is intended to apply it to other reservoirs in France.

The apparatus consists of two cast-iron syphon-pipes 27 in. internal diameter, 8-10 in. thickness of metal, through which the surplus waters are discharged. To these are attached two lesser auxiliary pipes, whose internal diameter is about 4 in. These latter communicate with the larger pair at the highest part of their curve, and are the means by which the discharge is regulated.

In order to protect the apparatus from frost, and from injury from any other cause, it is enclosed in a masonry chamber formed in the dam, and communicating with the reservoir by a port which is usually opened; it can, however, be closed for repairs, &c. There is a second port

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in the chamber which is closed by a sluice-gate. This is only opened to empty either the chamber or the reservoir. The upper part of the auxiliary pipes or feeders, which have been described as being attached to the larger pipes, does not communicate directly with the reservoir. This upper part is within the masonry chamber, about $\frac{1}{4}$ in. above the prescribed water level of the reservoir. Its attachment to the pipe is by means of a water-tight expansion joint, which allows it vertical play. As long as the reservoir is at below its prescribed water level the syphon is inactive; but as soon as it rises above that level it begins to flow away through the small pipe, and, the water continuing to rise, the head of the latter becomes completely submerged; the downflow of the water through the small pipe draws with it the air contained in the elbow of the syphon, and the latter begins to work until, the discharge having reduced the water to the prescribed level, air is readmitted to the bend of the syphon and its operation stopped. So long as the depth of water over the head of the feeder is less than 2 in., the whirlpool formed by the pressure of the atmosphere at the orifice causes the syphon to draw air as well as water, and therefore to discharge with reduced volume; as soon, however, as the water has risen to 2 in. above the head the syphon works full bore, and discharges at the rate of 1,500 gallons per second.

The apparatus is therefore self-regulating as well as self-acting.

The system claims, and appears to possess, the advantages of being simple in construction, certain in operation, and not liable to get out of repair.

The feed apparatus, which is the only novelty, is the idea of M. Hirsch.

Plans of public buildings and restorations in Paris.

The principal public buildings and restorations executed in Paris during the last 12 years are recorded in an atlas of plans exhibited by the Department des Travaux Publics. The extent of these works may be gathered from their cost, 6,630,180*l*. The designing of these works shows not only great skill expended upon the construction itself, but a skilful adaptation of site and judicious utilization of ugly waste spaces have also contributed to the general embellishment of the capital. It will be remarked that, in the designing of hospitals and lunatic asylums, great care has been taken to obtain a cheerful look-out from the ward windows. In the arrangement of the public abattoirs the approaches from the railway stations have been studied, so as to give the least amount of street through which cattle are

driven, whilst the disposal of the dead meat is made as easy as possible. None of these details have been left to take their chance. CAPT. COX ON CIVIL ENGINEERING, &C.

The next work selected for notice—an undertaking being carried on, not upon French territory, but the credit of which is due to France—is, perhaps, the most interesting object of civil engineering at present in progress in the world, viz., the cutting the maritime canal through the Isthmus of Suez, models, plans, photographs, and a panorama of which are exhibited in a detached building in the park, constructed in the style of an Egyptian temple. No one exhibit has attracted more of the attention of the visitors to the Champ de Mars than have these models, and none has better repaid the trouble of examination. The works which they illustrate deserve attention, alike from their great magnitude and importance from an engineering point of view, and from the greatness of the beneficial influence which their completion is likely to exercise upon the commerce of the world. The Suez Canal;

The idea of this great work, by which we hope the whole civilised world is shortly to be benefited, is due to M. le Baron Lesseps, who has long interested himself with the affairs of Egypt, having filled an important diplomatic post for many years in that country. The execution of the scheme is due to French engineering skill, and the principal part of the capital has been subscribed in France. originated by Baron Lesseps;

The works are illustrated by a model of the isthmus on a scale of 1-50,000th; the heights are comparatively exaggerated, 60 to 1; the width of the canal, 6 to 1.

The Isthmus of Suez, at the part selected for the operations of M. Lesseps, is about 72 miles wide, measured as the crow flies, from Pelousa, on the Mediterranean, to Suez, on the Red Sea. The level of these two seas is not far from identical, the mean level of the Red Sea being but $6\frac{1}{3}$ in. higher than that of the Mediterranean. The general character of the isthmus between Pelousa and Suez is flat, and is the natural water basin of the adjoining countries, which slope gradually towards the isthmus, east and west, from Asia and Africa. Starting from Pelousa, and following, southwards, the line traced out for the canal towards Damietta, we come to the lagunes of Menzaleh, about 25 miles long, separated from the Mediterranean by a strip of beach, which runs out shoal for a considerable distance into the sea. The Mediterranean mouth of the canal is cut through this strip; and here, situated 18 miles west of Pelousa, is Port Said, created by the company to be their base of operations, and where are established considerable workshops for the maintenance and repair of plant. its course,

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Formerly these desolate lagunes of Menzaleh were vast cultivated plains, which, fertilized by the Tanitique branch of the Nile, supported a considerable population, and grew a large quantity of the corn which supplied the granaries of ancient Rome.

After leaving the lagunes the line of the canal cuts through a strip of sand about four miles wide, elevated about 4 feet above the sea; this strip separates the lagunes of Menzaleh from those of Ballah, the width of which is fourteen miles. Then occurs the elevated plateau of El Guisr, the highest ground between Pelousa and Suez; through this the canal is carried in a very considerable cutting, nine miles and a half long, with maximum depth of 55 ft. After crossing this plateau a depressed plain is reached, called Lake Timsah; the lowest level of this plain is 19 ft. below the water of the Mediterranean. On the boarders of Lake Timsah, or Lake of the Crocodiles, is Ismailia, a town built by the company midway between the Mediterranean and Red Sea, where they have located the general direction of the works. The line then crosses a second elevated plateau, called Serapeum, 46 ft. above the level of the Mediterranean, and nine miles long. South of this lie the lakes of Amer, two shallow lagunes separated by a narrow strip of sand. The exact line which the canal will follow through Lakes Timsah and Amer has not yet been decided upon. This part of the canal will be left until the rest of the line is completed. Meantime, water communication across them is obtained by admitting the water of the Mediterranean into Timsah, and the Red Sea into Amer, thus transforming them into navigable inland seas. Beyond the lakes of Amer is the raised ridge of Chalouf, 26 ft. above the level of the sea, the southern slope of which forms the plain of Suez, elevated 6 ft. 6 in. above the sea level. After crossing this plain, the lagune of Suez is reached, which communicates by a shallow inlet with the Red Sea.

length,

Thus the total length of the canal is about 100 miles, of which 37 miles is in cutting, whilst 63 miles are at or beneath sea level.

The first work undertaken by the company, preliminary to their main work, was the extension, as far as Lake Timsah, of the old fresh-water canal, which starting from Moës, wound eastward, past Abassieh to Ras-el-Ouady. This extension gave them means of transport for their provisions and materials from the Nile into the very heart of the isthmus, a supply of water for their workmen and for their engines, and enabled them to establish their central depôt of Ismailia. Southwards from Ismailia the fresh-water canal

was continued nearly parallel to the intended line of the maritime canal as far as Suez, and northwards the water was led in pipes from a reservoir at Ismailia as far as Port Said, following the line of the works. The original source of supply of the fresh-water canal from Moëis was supplemented by a cut from the Nile at Boulak to Abassieh, 44 miles long; the cross section of the fresh-water canal is 56 ft. at water level, 26 ft. at bottom, and 6 ft. 6 in. deep.

dimensions

The general dimensions of the maritime canal are:—Width at water level in embankment, 328 ft.; ditto in cutting, 190 ft.; width at bottom, 72 ft.; depth, 26 ft. 3 in.; the batter of the sides varies with the nature of the soil, the steepest slope being about $2\frac{1}{2}$ to 1.

and sectional form.

The sectional form of the canal has been the subject of anxious consideration. It was originally intended to make it somewhat narrower than the above dimensions, and steeper at the sides; but it was found that at or near the water's edge a slope as steep as 2 to 1 was subject to degradation from the wash of passing vessels. The general batter from about 4 ft. below water level to the bottom is now intended to be from $2\frac{1}{2}$ to 1 to $3\frac{1}{2}$ to 1, whilst the edge is considerably flattened, so as to approximate to the shelving form which sand assumes when acted upon by the wave from passing vessels.

History and nature of the work.

The first work of digging through the strip of head separating the Mediterranean from the lagune of Menzaleh was performed by fellahs supplied by the Egyptian Government; the mode of operation was the old one of scooping the sand and carrying it in baskets on the head. The work of the fellahs was confined to the higher and drier parts of the excavations, the lower part being performed by means of steam-dredges, 20 of which were put in operation by the company; these dredges were driven by 15-horse power engines, lifting 26 gallon buckets at the rate of 20 per minute. The sand dredged north of the beach was deposited to form the platform upon which Port Said was subsequently built; the sand excavated on the south side was placed so as to form the canal banks, *en cavalier*, through the lagunes. By these banks the waters of the canal were isolated from those of the lagunes, guarding at once against sudden variations of water level arising from storm, and protecting the bed of the canal from being stilted up by sand blown across from the plains. A good illustration of the works in the great cutting of El Guisr, as carried on by fellahs, is given in the drawing which hangs on the wall on the right on entering. When this cutting was about half accomplished, the supply of fellah labour by the Egyptian

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Government was stopped: the primitive baskets of sand carried on human shoulders disappeared from the scene, and were replaced by MM. Borel and Lavally, and M. Couvreux, contractors, with steam instead of human power.

M. Couvreux contracted for the enlargement to its full destined width and depth of the cutting of El Guisr. Messrs. Borel, Lavally, and Co. undertook the remainder of the work. The modes of carrying out the works adopted by Messrs. Borel and Lavally are shown in the great model in the centre of the room. The model on the left bank of the canal shows the mode of disposing of the sand dredged from the bed of the canal—by tipping the dredge-buckets direct into a long shoot which leads inshore from the top of the dredge frame. This shoot is inclined towards the shore at a gradient sufficiently quick to enable the silt charged with water to flow along it. The discharge is assisted by pumping water into the dredge end of the shoot, by means of two rotatory pumps worked by the engine of the dredger, supplemented, in case the nature of the silt requires further liquefaction, by a second pump placed upon the barge, and worked by a portable steam-engine. The descent of the silt is further helped by scrapers, fitting the concave surface of the shoot, attached to endless chains passing over pulleys fixed at each end of the shoot. These scrapers are also driven by the dredger-engine. These shoots are 230 ft. long; their section is a semi-ellipse, 5 ft. wide and 2 ft. deep.; they rest upon a pair of lattice girders, which latter are carried by an upright iron framing, standing upon a barge moored inshore of and parallel to the dredger. Lateral and vertical play is allowed for in the attachment of the shoot to the top of the frame of the dredger, and to the frame carried by the barge. The dredger-engine is a direct-acting, double-cylinder condensing engine of 35-horse power (nominal). The gradient of the shoot is varied to suit the description of the silt dredged. To discharge fine sand a fall of 1 in 20 is sufficiently steep, but the pumps have to supply a volume of water equal to half the sand; with clay a fall of 1 in 12 is necessary, but less water suffices. The mode of disposal above described is the most expeditious and economical in use on the works; it is applied in all cases where the height of the bank is not too great. Each dredger and shoot is calculated to dispose of about 1,200 cubic yards per day.

Where the banks are too high to be commanded by the shoot, another apparatus is used, the "appareil elevateur," a model of which is shown upon the left bank of the canal. This apparatus is designed to lift trucks full of sand from barges and run them to tip inshore. It consists of two

parallel lattice girders, extending from a barge moored to the shore, in a direction parallel to the canal, carrying upon their upper edges a tramway, which rises shorewards at a gradient of about 1 in 6; the lower end of these girders is about 10 ft. above the level of the water, the shore or higher end 46 ft. This frame is supported at two points about 14 ft. apart, viz., one on a barge moored close alongshore, the other on a platform carriage on the shore. Sufficient preponderance is given to the canal end to support the shore end, together with the weight of a full waggon. Very considerable ingenuity is exhibited in the arrangement of the framing, and in its attachment at its points of support, so as to render it sufficiently flexible to be non-susceptible of injury from the rolling of the barge, whilst its strength is sufficient to carry the weight of the full trucks running over it. On the tramway runs a carriage, consisting of two pairs of flange wheels and axles, kept about 4 ft. apart by means of two horizontal pieces resembling the fiddle-sticks of a tip-waggon; the wheels are keyed to the hinder axle; they run loose on the fore axle. To this carriage is slung the sand truck, and it is the vehicle by which the latter is carried inshore. The fore axle of the platform carriage is thickened between the wheels, so as to form two drums of different diameters; to the lesser of these is attached a rope, which lifts the sand-trucks from the barge, and to the larger a second rope is attached, which passes over a pulley-wheel at the shore end of the tramway, and which draws the full waggons up the incline from the barge. The working is as follows:—The sand, which has been shot by the steam-dredger into boxes resembling ordinary end-tip waggons, containing about three yards cube, is carried by a barge to the lower extremity of the elevator; a tackle attached to the small drum above described is hooked on to rings in the side of the waggon; the waggon, thus slung to the platform carriage, is hoisted by the engine to a height sufficient to allow of two small truck wheels, which are attached to the hinder end of the waggon, being engaged in the metals of a second tramroad placed below, and for five-sixths of its length parallel to the first. The engine, by pulling over the pulley-wheels, drags the carriage up the incline to the shore end of the elevator. The discharge of the contents of the sand-waggon is managed in the following way:—As has been already stated, the upper and lower tramways are laid parallel to each other throughout about five-sixths of their lengths. At the shore end, however, they converge, the gradient of the lower tramway, on which run the small truck wheels of the sand waggon, being considerably steepened; the hinder part of the waggon is thus borne

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up, whilst the forward or tip end is thrown down, so that the catch of the tailboard being disengaged the contents are shot. The empty truck then runs down the incline, is lowered into the barge, and a full one picked up. There are at present 18 of these elevators at work; each of them takes two of the large dredgers to feed it.

M. Couvreux has employed an apparatus, termed a dry dredger, in the enlargement and deepening of the great cutting of El Guisi. The apparatus consists of a platform carriage 20 ft. long by 10 ft. wide, mounted upon nine wheels, running on a three-rail tramway. On this is a steam-engine driving a chain of dredge buckets, which mount a jib projecting perpendicularly from the platform carriage, and which tip their contents into sets of earth-waggons which run upon a second tramway parallel to the first. The trains of sand waggons are then run to tip by a locomotive. Each of the dry dredgers shift about 900 yards cube per day of loose fine sand. The soil met with in the line of excavation for the canal is chiefly sand, river mud, and clay. A vein of rock crossing the ridge of Chalouf, about 3 ft. above the canal bed, is the only excavation which requires blasting.

Port Saïd.

A very considerable work in connexion with the undertaking of M. Lesseps has been the construction of Port Saïd, the Mediterranean harbour of the canal. This port is formed by two breakwaters running out a considerable distance into the sea, their shore ends being 4,592 ft. and their sea ends 2,296 ft. apart. The west breakwater is 10,168 ft. in length, the east 5,000 ft. Their upper surface is 17 ft. wide; their sides batter 1 to 1 to the base. The harbour enclosed by these breakwaters is being dredged out to a uniform depth of 30 ft. The material used in their construction is concrete blocks composed of sand and ground lime of Theil (from Ardèche, in France), the proportions being one of lime to four and a half of sand. The works of Port Saïd are being carried out by MM. Dussand, who have already constructed, with the same material, breakwaters at Marseilles, Cherbourg, and Alger. MM. Borel and Lavally have guaranteed the completion of their works on Oct. 1, 1869.

The great work, of which the above is a very brief and imperfect sketch, will well repay an attentive study. There is no country so directly interested in its success as is England, the mistress of India. Hitherto it has been the fashion to consign the Suez Canal to the limbo of great impracticable schemes; we venture to think that amongst the many doubting Englishmen who have visited the models in the Paris Exhibition, and have been induced to inform

themselves of what has been done and is doing, there are not a few who will have their scepticism in the feasibility of the scheme somewhat shaken.

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America exhibits but few specimens of her engineering skill, and respecting those few it was by no means easy to obtain much detailed information.

America.

A bold engineering scheme for the supply of water to the city of Chicago, in Illinois, is recorded on a plan hanging against the west wall in the United States section, numbered 7 in general catalogue.

Scheme for the supply of water to Chicago.

Chicago, the capital of Illinois, is situated upon the great lake of Michigan, whence it derives its supply of water.

The pollution of the water near the shore, proceeding from the discharge of the town drains, &c., rendered it necessary that the supply for the use of the town should be drawn from a considerable distance out in the lake, and with this view a shaft consisting of cast-iron pipes 9 ft. diameter and $2\frac{1}{4}$ in. thick (in seven lengths of 9 ft. each) was sunk from the surface of the water two miles from shore to about 35 ft. beneath the bed of the lake. The depth of the lake is here about 28 ft.

The part of this pipe which extends from beneath the level of the bed of the lake to its greatest depth is cased with brickwork in cement. The part of the pipe which stands in the water is protected from the action of the waves by a breakwater built round it in the form of a pentagon. This breakwater is a strong wooden framing, filled in with coarse concrete or rubble masonry. From the lower extremity of this shaft, 63 ft. below the surface of the lake, a circular tunnel, lined with brickwork, in cement, and 5 ft. diameter in the clear and two miles in length, is driven beneath the bed of the lake towards the town, where it meets a second vertical shaft sunk within the shore line. This latter communicates, through a chamber containing five wrought-iron regulating sluice-gates, with a reservoir, from which, by means of a large pair of pumping engines driven by steam power, the water is lifted to a water tower 120 ft. high, and distributed all over the town. A legend on the plan states that the work is the design of Mr. Coote, and that it has been three years in construction.

A good example of the ingenious application of wood to bridge construction, for which America is famous, will be found in a model 1-40th full size of a wooden railway swing-bridge, which has recently been constructed in the State of Ohio. Timber bridges are specially suited to a new country where timber is cheap, and where it has been necessary to open up a new country rapidly and economically. These

Wooden railway swing-bridge.

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structures are, however, to be considered as essentially temporary in their character, and are generally built with a view to their being replaced at some future time in some more durable material. The bridge exhibited here is of a larger span than usual in designs of this class. Each opening has a clear span of 150 feet; the diameter of turn-table is 30 ft.; length of bridge over all, 335 ft.; the depth of the truss is 10 ft. at the ends, 34 ft. at the centre. The arched part is composed of four timbers, 10 in. by $6\frac{1}{2}$ in.; main struts, 14 in. by 8 in., extend to each side from the turn-table to give support to the arched top, which is further strengthened by three straining pieces 8 in. by 10 in. The chord consists of four 12 in. by $6\frac{1}{2}$ in. timbers, and is put together with a camber of about 6 in. The weight of the bridge is 200 tons.

Within the space to which it is necessary to restrict this memorandum it has been impossible to do more than briefly to call attention to a few of the most noteworthy exhibits. It will be seen that, though the progress of civil engineering has not been fully represented, no country having put forth its full strength but France, there is still much exhibited that is interesting and instructive.

## Report on Limes and Hydraulic Cements.—(Class 65.)—By Lieut.-Colonel Scott, R.E.



Lime has many important applications in the arts, dependent on its powerful basic properties and the facility with which it is everywhere to be obtained at a low price, but the following observations will be confined to its use in building for the production of mortar, as exemplified by the specimens to be found in the Paris Exhibition.

By mortar is to be understood a mixture or combination of lime with other substances, which, when used to cement together bricks and stones, possesses the property of hardening.

Classification.

This hardening is in some cases chiefly due to the action of the air and will not take place under water, and in others is chiefly attributable to the agency of water and is most pronounced when the mortar is kept constantly in a moist condition. There are again intermediate cases in which the solidification is more perfect when both the action of the air and a certain amount of moisture contribute to the result.

The three cases are—

1st. Common, or, as they are technically termed, "fat" or "pure" limes.

2nd. Hydraulic or intermediate limes.

3rd. Hydraulic cements.

Of the first little need be said. Common limes are not largely exhibited, and as a building material common lime is now considered by the well-instructed builder to be of the least valuable description, but inasmuch as many persons who ought to be conversant with the nature of materials used in building construction are frequently induced to use common limes, excepting in wet or damp situations, from a belief that though slow in hardening they will ultimately attain great strength, it may be of advantage to point out that such ideas are erroneous and contradicted by well ascertained facts.

Fat or pure limes.

Pure limes are the results of the calcination of pure limestones by the expulsion of their carbonic acid gas. When moistened with water, they slake with great violence, evolving much heat and crumbling to a soft, white, very bulky powder, which contains about one-fourth of its weight of water. By a fresh addition of water the bulk of the powder

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is considerably reduced, and the paste thus formed, if allowed to dry out of contact of the air, shrinks to a porous substance of no great hardness, or if kept moist, always remains of a soft consistency. Cases are on record of old mortar pits retaining common lime in a state similar to that in which it exists when fresh slaked, for 300 or 500 years, and observation shows that in dry walls the mortar made with such lime is for the most part little better than dust. Such hardening as it is capable of is due to the carbonic acid of the atmosphere, which restores the lime to its original condition of a carbonate of lime. So far as this gas can penetrate the pure limes will harden satisfactorily, but no further. It has been sometimes supposed that the sand mixed with the lime in forming mortar contributes to the solidification, but the chemical action between the lime and the sand is inappreciable in its results, and practically it really does no more than prevent the mortar from shrinking. As a cementing material, therefore, such common limes have little value, but they succeed better for internal plastering when the mortar is made to present a comparatively extended surface to the action of the carbonic acid gas of the atmosphere.

Fat limes exhibited.

Common or pure limes are represented in the French sections by specimens exhibited by Binette of St. Julien-sur-Calenne; J. Meury, Paris; and by Carvin-fils of Marseilles, to whose works reference will have again to be made. In the Spanish section, the Ayuntamiento of Guadalajara and that of Torija, the Deputacion Generale of the province of Alava, and the Burbano Brothers, of Saragossa, exhibit specimens. Italy also shows a sample or two. Beyond these there is little to note in the way of common or pure limes, but, as has been already stated, the pure limes form a poor material for building purposes, and for such employment their interest will be usually confined to the localities in which they are found.

Hydraulic limes and cements.

The hydraulic limes and cements are better illustrated, so far as the exhibition of a great number of specimens are concerned, but the specimens are with few exceptions unaccompanied by any information beyond the name of the manufacturer and the place of production. In one or two instances only are analyses given and information concerning the geological position of the beds from which the lime is procured. Very rarely is there any means of ascertaining the resistance to be expected from the mortar made from it according to varying conditions of employment, and in the majority of cases the exhibitors have not even added to the limes specimens of the stones from which they are derived.

Hydraulic limes and cements are really obtained from

impure limestones, or from combinations of carbonate of lime and clay artificially prepared to imitate them.

Limestones containing clay (silicate of alumina generally admixed with iron) when calcined lose their carbonic acid gas as the pure limes do; but the clay facilitates its expulsion in consequence of the affinity of the silicic acid for the lime. The clay also parts with its combined water. A further action then takes place; the silicic acid of the clay and the lime react on one another under the influence of the high temperature of the kiln, and either form a silicate of lime, or so far approximate to its formation, that on the addition of water a silicate is formed with more or less rapidity. This action is more perfect in the water cements than in the water limes, owing to a better proportion of their components; but still the difference between them cannot be precisely defined with reference to chemical composition, for some limestones will yield the one or the other, according to the temperature of their calcination; it must rather be referred to the manner in which they behave when moistened with water. If a piece of cement be dipped in water for a few seconds until it ceases to hiss from the escape of air from its pores it may become harder, or it may after a time break up into rough fragments with or without sensible warmth. If on the other hand a piece of fresh pure lime be treated in a similar way it begins to heat and swell in a few minutes, and the violence of the action is such as to throw it abroad to a bulky impalpable powder. A piece of impure lime containing a notable proportion of clay will, under the same circumstances, show an action intermediate between that of the cement and the pure lime. It will absorb and combine with a larger quantity of water than the cement and a less quantity than the pure lime, and the proportion of water necessary for slaking limes and the violence of the slaking action may generally be regarded as inversely proportionate to the quantity of clay they contain. The bulk of the powder resulting from the combination of lime with water will also vary inversely with the quantity of clay present.

This latter point is well illustrated by some specimens exhibited in the Belgian section. They are in the round building in the park. The stone of the quarry of Creve Cœur contains 10·3 per cent. of clay and yields a lime which gives a bulk of 250 parts for every 100 parts unslaked. That from the quarry of the Faubourg de Vaux, which contains 19·5 per cent. of clay, gives 190 parts for every 100 parts unslaked. And that from the quarry of Alain, containing 26·8 per cent. of clay, gives only 120 to 150 parts of slaked lime for every 100 parts unslaked.

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The last of the three limestones is probably just one of those cases above referred to in which a lime or cement will result according to the temperature at which the stone is burned. Cement powder decreases in bulk when mixed with water.

Again, when lime is wetted one affinity only comes into play, viz., that of the lime for the water; but in the case of cements and hydraulic limes a second affinity is brought into operation. As has been already mentioned, in the process of burning an action is set up between the lime and silicic acid of the clay, and when such compounds are moistened this affinity moderates the affinity of the lime for water, and they pass into the state of hydrates either quietly, as in the case of cements, or with a reduced violence, as in that of hydraulic limes. The hydrated silicates thus formed are not afterwards appreciably affected by water, and so much of the lime as the silicic acid can take up passes from the soluble to the insoluble condition. If the heat of the kiln be too far urged vitrification ensues from the complete formation of an anhydrous silicate, and a comparatively inert substance is produced which undergoes no change on being mixed with water, or will only unite with it after considerable periods of time.

In what hydraulic limes and cements differ.

The hydraulic limes, as it will appear from the above remarks, are then intermediate between the cements and pure limes in chemical composition as they are in the increase of bulk resulting from the action upon them of water. The proportion of clay in them being generally smaller than in the cements, the lime sufficiently predominates to produce, by its violent affinity for water, the degree of heat, expansion, and amount of vapour requisite to throw them into powder. When the quantity of clay as compared with the lime is small, the violence of the slaking is scarcely less than that of the pure limes, but in proportion as the clay relatively increases in amount, the heat generated in combining with water is less, and the lime slakes to a powder more imperfectly, and, as shown in the above Belgian examples, with less increase of volume; until at last on reaching the boundary of the cements, the slaking must be urged on by confining the heat generated, and the slaked lime be allowed to lie longer before use to ensure the completion of its action, before it is employed in work. A want of attention to this precaution frequently leads to serious results, large masses of masonry being sometimes lifted by the subsequent slaking and swelling of sluggish particles which have been over calcined.

The slaked powders of hydraulic limes, then, consist of hydrate of lime and of silicates of iron and alumina which have been converted in the process of burning into that condition

in which, the silicic acid having undergone great modification, they can unite with the lime to form new hydrated compounds similar to those which result from the action of cements; the only difference appearing to be that whereas in the case of cements, the formation of the hydrated silicates takes place chiefly simultaneously with the hydration of the lime; in that of the hydraulic limes their formation is a subsequent process, and occurs after comparatively long periods, which may be measured by weeks, months, and years, instead of minutes, hours, and days, the rapidity of the solidification, when other conditions are similar, being proportioned to the amount of silicate of lime which the silicic acid present in the clay can form. Thus in the Belgian hydraulic limes from the neighbourhood of Brussels already quoted, the proportions of clay in the stones being 10·3, 19·5, and 26·8 for the quarries of Creve Cœur, the Faubourg de Vaux, and of Alain, respectively, the periods given for their "set" or moderate induration are 30 days, four to 12 days, and two to four days; and Boulogne cement, exhibited by Demarle Lonquety & Co., which is prepared from the same pebbles as are used for the Sheppey or Roman cement, containing, according to Berthie, 32 per cent. of clay, sets in four or five minutes.

Hydraulic limes exhibited.

The hydraulic limes exhibited by France are chiefly from the Lias and Lower Chalk formations, which also yield most of our own hydraulic limes. Duru & Co., Lyons, exhibit limes from the white and blue lias beds; Binette, a hydraulic lime of very good quality, apparently from the same formation; and several firms exhibit the Theil lime, which has long had a great reputation. This lime was used for many bridges over the Rhine between Lyons and Arles, and the stone from which it is prepared contains, according to Vicat, 20·5 per cent. of clay.

Specimens of Theil lime are shown by Briand, Pavin de Lafargue, and Couturier Souillier & Co. According to Vicat, this description of lime is found throughout the country from Saint Andéal to Voutte.

From the Lower Chalk formations, the Senonches lime is shown by Poujol & Sons and by Lejard & Company. Like the Theil lime, it enjoys a high reputation, and it resembles in quality as well as origin our grey chalk limes. The eminently hydraulic lime of that district contains 29 per cent. of silex for 70 per cent. of pure lime, but that which Poujol & Sons exhibit can hardly contain so much as this, judging from its appearance as compared with English specimens of the same formations. A darker lime from La Mancelière, shown by Lejard & Co., looks like a very good lime, and is probably prepared from the lowest beds of the Chalk forma-

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tion, consisting of marls which when burned and wetted hardly fall to powder, and which contain 24 to 26 per cent. of clay. Maury Jules also show a rich grey lime prepared from the calcareous marls of Champigny, and the specimens of calcareous marls exhibited by the firm of Carvin-fils of Marseilles have considerable interest. When Vicat, about 35 years since, visited this place in search of hydraulic limes, he found a large quantity of a marly chalk being carried away from the excavation for a dock basin, and thrown into the sea at some distance off. On experimenting with the material he found that what was thus being thrown away at a heavy cost might have been used to great advantage for the preparation both of hydraulic lime and cement. The coloured section, exhibited by the Carvin-fils, is of quarries in the neighbourhood. It illustrates very well the great variety of material often found in small compass. The beds show a composition suitable for the preparation of both limes and cements. The Bedoule lime exhibited by them, is prepared from what is termed white siliceous chalk, which contains 16 per cent. of silicate of alumina and iron.

The Austrian section has a few specimens of hydraulic lime, which, though named in the catalogue, I was unable to find; and there are also a few Spanish and Italian specimens, the latter arranged with some care, and this procured for them the favourable notice of the jurors. The most interesting series of hydraulic limes is, however, the Belgian one already spoken of, from the neighbourhood of Brussels.

Roman cements exhibited.

Specimens of quick setting cements, generally termed by the exhibitors "Roman cement," whatever their origin, are shown by several manufacturers; among these are:—A light Roman cement, which when set has something the appearance of Portland. It is made by the Carvin-fils, from the beds mentioned in the section shown as containing from 24 to 30 per cent. of clay. "Ciment de la Mediterranée," shown by Desiré, Michel, and Co. This has somewhat the appearance when burned of the English Bath cement, which is made from one of the beds of the Lias formation. The unburned stone is semi-crystalline, not unlike the Harwich stone, with veins of buff, brown, and black. The celebrated Pouilly cement is shown by Lobereau and Meurgey. This cement shows considerable variations in its composition. One specimen is given by Petot, as consisting of 42·86 lime to 57·14 clay, and a second 36·37 lime to 63·63 clay; proportions of clay which seem excessive. Vicat gives a third specimen as containing less than half the proportion of clay (a proportion of clay indeed what would not yield a cement at all, but only a hydraulic lime), and a fourth, as containing

about two-thirds of it, which would give a very good cement. The cement of Nevers, exhibited by Faucon & Co. (cement of Baye?), contains, according to analysis given by Petot, a still larger proportion of clay than the first-named specimens of Pouilly cement—so large a proportion of clay indeed as would prevent its acting as a cement in the ordinary sense of the term, but it is hardly possible that the samples taken for analysis can have been fair specimens. The analyses of the first and second Pouilly specimens and that of Baye are from Petot's researches. Lobereau and Meurgey also exhibit a quick setting cement, prepared apparently from blue lias stone, and burning yellow, brown, and black, and also cements from the Lower Chalk. In the Belgian section quick setting cements are exhibited by Clautriau and Culot, Jossen and Delangle, and others. The cement of Jossen and Delangle is, in appearance, very like the English cement known as Atkinson's cement, which is prepared from stones found in the alum shales of Yorkshire. It comes from Niel, province of Antwerp.

Portland cements exhibited.

Just as the term Roman cement has been adopted from the English for all quick setting cements by every nation of Europe, so the English term "Portland" is also generally made use of. Portland cements are exhibited in the French section by Vicat & Co., who show some excellent specimens of mosaic work in this material; by Demarle, Lonquety & Co., already mentioned, who have made a very complete exhibition in the park; by Faucon & Co., whose material has a brown tinge similar to that which results from too much clay; by Agombart frère et sœur; by Lobereau and Meurgey, who have a cement basin in the park, Belgian section, and by the Carvin-fils, of Marseilles.

In the Belgian department the chief exhibitors of Portland are Jossen and Delangle, of Antwerp, and Clautriau and Culot, of Hainault. Prussia exhibits this cement largely. The manufactory of Lunebourg sends some specimens of good colour. The Portland cement of Bonn, of which several coloured specimens are shown, appears, from a report given by the Administration of that place, to wear well in floors. The Stettin Portland of Lossius and Delbrück is also good. The specimens sent by Menkow Bros., of Schwerin, show softness below the upper crust. The specimens in powder appear to be insufficiently burned. Grundmann's cement, from Katowitz, is of better quality than the last; but some cement from Ulm again appears to have much underburned material with it.

Charles Lothary, of Mayence, the Grand Duchy of Hesse, has erected several objects in Portland cement in the

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park. Now, towards the end of the Exhibition, these show cracks in all directions; no one specimen is sound, some are absolutely crumbling to pieces. In the Exhibition building this manufacturer has a large number of prepared blocks of his cement and a testing machine. Some of them are in first-rate condition, and, judging by them alone, the gold medal awarded by the jury appears well bestowed; but several of the samples, like the park objects, are fast crumbling away, indicating probably that, in aiming at too great strength, the minimum for the proportions of clay had been passed, and the unsafe condition above alluded to reached. When the award of the jury was made, no means within their reach for detecting this flaw practically existed, and this instance shows how difficult it is to arrive at any safe conclusion respecting the quality of a cement from the exhibition of a few samples only. C. Lothary has, however, evidently the means of making a first-rate Portland cement, the failure of his specimens in the Exhibition notwithstanding.

Failure of the Portland cement which received the gold medal.

In the Spanish section is a dark cement from Alava, and cements are exhibited by Burbano Brothers, Saragossa, which are not unlike in colour the English Bath and Sheppey cements.

The Messrs. Lucas, Berthollett, & Co., Florence, exhibit a cement of a very light brown colour, more pleasing in tint than any other cement I have seen. It seems of fair quality also, and must be very valuable for casting.

In the American section one cement is exhibited, that from Louisville, Kentucky. This cement has been extensively used on the Mississippi, and enjoys a high reputation.

All the foregoing cements are the counterparts of our English cements, known as Harwich and Sheppey, or Roman cements, Medina cement, and Atkinson's or Bath cements. Their chemical characteristics among cements are a large proportion of iron and alumina, as respects the silicic acid of the clay. The presence of large quantities of iron and alumina, and especially of iron, greatly facilitates the action which takes place during calcination, and as the consequence of this they are burned with a smaller quantity of fuel, and their combination with water in setting is more rapid. In Portland cement, which is more largely exhibited than any other cement, the alumina and iron together do not generally exceed in quantity one half of the silicic acid. It will stand a far higher temperature without fusion than the best quick-setting cements, but it is burned to incipient vitrification, and its set is consequently comparatively slow. It takes, indeed, as many or more hours to solidify as the

quick-setting cements take minutes. There is a generally prevalent opinion in England that this cement is made from Portland stone, but the Portland stone would not yield a cement. Portland cement is really prepared chiefly from a mixture of chalk and clay, in the proportion of 75 chalk to 23 or 24 of clay, and had this name given to it from a supposed resemblance to the colour of that stone. Some of this cement is, however, prepared from the soft argillaceous beds of the Lower Chalk containing these ingredients in the proper proportion, and specimens of such cements are exhibited by Demarle, Lonquety & Co. In the ordinary process with clay and chalk dug separately it is customary to grind the ingredients under vertical iron wheels with a large quantity of water, and subsequently to allow the water to stand in large tanks or vats, technicaliy termed backs or becks, until the fine particles in suspension settle down; but in the Boulogne process enough water only is added to form a plastic paste of the argillaceous chalk, which after passing through the mill is shaped into small bricks, and these when dry are placed in a kiln and burned at a white heat until partial agglutination takes place. In the process for making artificial Portland cement, the paste which settles at the bottom of the vats is first freed from water as far as possible by constantly drawing it off from the surface of the vat, and is then dried over ovens with the flare of the coal used in the preparation of the coke with which the cement is subsequently calcined, and roughly broken up for the kiln. After calcination a selection is necessary, the underburned portions being again passed through the kilns, and portions actually fused to scoriæ thrown away. The portions properly calcined are of dark grey colour, with a greenish tint, somewhat warped and split by contraction. When ground they take a lighter shade, and the powder should weigh as much as 110 or 112 lbs. per bushel. Portland cement of good quality is the strongest cement known, and is not subject to quick deterioration from exposure to the air and moisture. Up to a certain point indeed, it is improved by such exposure, as underburned portions, retaining somewhat of the avidity of lime for water, are thereby "killed," and the set of the whole is simultaneous. The cement gains in strength if the proportion of clay is kept as low as 20 per cent., but cement containing so small a proportion of this ingredient is apt to swell in the work. Too large a proportion of clay gives a rusty tinge to the cement after it is set. Austrian manufacturers of limes and cements also exhibited Portland cement. In Spain are found two or three exhibitors of fair specimens of it, and from Italy are specimens professing to be made on Vicat's

Preparation of Portland cement.

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system, modified by Berthier and Rivot, the peculiar advantages of which mode of treatment do not appear.

Puzzuolana and Trass.

The substances called Puzzuolana and Trass were at one time largely employed in the preparation of mortars to resist the action of water, but since the introduction of cements, and especially of Portland cement, which resists water so much better, these substances have lost much of their interest. Some 25 years since, Puzzuolana was brought to England from Italy in considerable quantities for marine works, and it was used, for instance, at the Liverpool docks, the Plymouth breakwater, and in similar works, but the trade has now entirely ceased.

These substances are of volcanic origin. Puzzuolana was first discovered at the foot of Mount Vesuvius, near the village of Puzzuoles, and hence its name; but it has since been found to be largely disseminated throughout Europe, the chief supplies for England having been derived from the neighbourhood of Rome and Civitâ Vecchia. It is generally found in the state of coarse powder, and is rough to the touch like scoria. A specimen examined by Berthier had the following composition :—

| | |
|---|---|
| Silex - - - | 44·5 |
| Alumina - - | 15·0 |
| Lime - - | 8·8 |
| Magnesia - - | 4·7 |
| Iron oxide - - | 12·0 |
| Potash - - | 1·4 |
| Soda - - | 4·0 |
| Water - - | 9·2 |
| | 99·6 |

Trass or Terras has somewhat of an analogous composition, and is likewise of volcanic origin, but considerable variations are found in the components of such substances. Trass is found in the valley of the Rhine between Mayence and Cologne, and also in Holland. The Dutch engineers made great use of it, and large quantities of it were formerly exported.

These substances are mixed with fat or hydraulic limes after being ground to powder, or the lime and the Puzzuolana or Trass are ground together. They owe their hydraulic energy to the presence of silica in that condition in which it can enter into combination with lime and water to form hydrated silicates similar to those already described when speaking of hydraulic limes and cements. The silex has been probably brought to this condition by the action of

the potash, soda, and lime under the influence of volcanic heat. Specimens of Trass are exhibited by Jossen and Delangle in the Belgian department; by Saint Martin of Winningen, and Meurin of Andernach, in the Prussian; and by the Society of Kasehan Helggaljay in the Austrian. Puzzuolanas are exhibited by two or three Spanish manufacturers of lime and cement, and by Marcarelli, Silenzi, and Cesaro in the Italian section.

Specimens of Puzzuolana and Trass exhibited.

In using such substances as Puzzuolana and Trass, two or two and a half parts of the one or the other may be added to one part of fat lime, two or two and a half parts of sand being added to the mixture.

It is worthy of remark that England, which first produced Roman and Portland cements, has sent no cement to the Exhibition, excepting some coloured specimens by Mr. Sandham of the South Kensington Museum, (which have an interest from the success obtained in point of colour and not on account of the material of which they are made,) and some examples also of the use of Keene's cement by Messrs. White Bros., which being a preparation of Plaster of Paris does not fall within the scope of this report. One of the British colonies however sends some specimens of a quick-setting cement. Canada sends some Quebec cement which resembles in its qualities the English Roman cement, but I was unable to find the specimens. Charmed with the arrangements of the Exhibition, so long as close investigations of its contents in any particular branch of manufacture was not my object, I found much difficulty in ferreting out the different specimens of lime and cement named in the catalogue when I attempted to collect the materials for this report, and many of them I never found at all. M. Mortillet in his introduction to his "Promenades Prehistoriques," says, that the first gallery around the central garden "Est celle "qui contient en majeure partie les richesses pre'historiques "—cependant nous aurons à faire plusieurs excursions dans "*d'autres parties du palais et même en dehors.*"

No cements exhibited by England.

Now the lime and cement riches are not chiefly to be found in any part of the Exhibition in particular, and the difficulty I consequently met with in tracing them out needs no explanation.

MODELS of SHIPS and LIFEBOATS.—(Class 66.)—By CHARLES W. MERRIFIELD, F.R.S., Principal of the Royal School of Naval Architecture and Marine Engineering, and Honorary Secretary of the Institution of Naval Architects. MR. MERRIFIELD ON MODELS OF SHIPS, &c.

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IN compliance with the instructions which I have received I have prepared my report with a view to its being a popular explanation of the exhibition of the models of ships and lifeboats, and of the principles which they are intended to elucidate, rather than a record of the exhibits. Object of report.

Two leading features distinguish the present exhibition of naval architecture from all previous exhibitions; the almost universal adoption of armour-plating for ships of war, and of steam propulsion for vessels of commerce. With the exception of a few yachts, there is very little representation of the class of sailing vessels. Leading features of Exhibition.

The Governments of France and England have been careful to send very complete series of models of their fleets. England has sent by far the greater number of models; but the French models are fully rigged, while the English Admiralty has only sent half-block models. These contain a useful lesson to the naval architect, while they are somewhat too technical for the general public. Many of the large shipbuilding firms have also contributed models of existing vessels and designs for new ones; among the former are to be found many of the ironclads of foreign countries. The United States of America have sent no models of their monitors. The visitor may, however, see what this type of vessel is from a model exhibited among the Russian ships.

As regards seagoing ships of war, the chief points of interest to the observer will naturally be the comparison of the English and French navies on the one hand, and of the turret and broadside systems on the other. The materials for the comparison might have been considered as very complete but for the remarkable gap caused by the absence of any representative of Ericcson's monitors. The French Marine and the English Admiralty illustrate almost all possible broadside arrangements; while the models exhibited by Messrs. Laird and Co., of Birkenhead, and Messrs. Napier, of Glasgow, with a few more built by Messrs. Samuda and others, afford Comparison of French and English navies.

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a very complete view of the turret system of Captain Cowper Coles.

The guiding idea of the French seems to have been the construction of a uniform fleet or squadron, while that of the English seems rather to have been the production of the best individual vessels for fighting purposes. Accordingly, there is a far greater variety in the exhibition of English vessels; while the French seagoing fleet is sufficiently represented by three or four types, the difference from class to class being far less than with us. They claim the following advantages that even granting (which they do not allow) that certain individual English vessels are superior to any in their navy, yet that their average performance is better than our average, and that their uniformity gives them a greater power of manœuvring together as a fleet. They also consider that their ships steer more easily than most of ours.

Besides this difference in the primary condition of the problem, there are certain secondary points which distinguish their system, and amongst these the chief is the invariable use of wood for the construction of the immersed portion of the hull. Their general type, then, is a short ship with a wooden hull, coppered on the outside, an armour-plated belt going round the whole load water-line of the ship for some distance both above and below, and, if the belt does not extend upwards to the waterway, a central battery of either one or two decks, also protected by armour-plating. The upper works, both forward and aft of the central protected portion, are of light iron plate, it being considered sufficient to protect them against the danger of taking fire, without making any attempt to render them shotproof. The modern adoption of very heavy guns has obliged changes to be made in the detailed arrangements of the ships, but these are not such as to affect their seagoing qualities disadvantageously.

Artillery and steam-engines are the subject of separate reports, and I shall not presume to make any attempt at discussing these; but I find it necessary to allude to those points relating to them which affect the naval architect.

Naval Ordnance.

The heavy sea-service guns of the present day vary from the 9-in. gun, weighing 12 tons, and throwing a projectile of 250 lb. with 43 lb. of powder, at an initial velocity of 1,370 ft. per second, to the 12-in. gun, weighing 23½ tons and throwing a projectile of 600 lb. weight with 70 lb. of powder, at an initial velocity of 1,240 ft. per second. It is doubtful whether the larger gun will ever be used in the broadside. But the 12-ton gun necessitates very different arrangements on board a ship, both in respect of height between decks and of size of battery, than was necessary even for the old 68-

pounder. The absolute length of the slides is 13 ft., and a space of 25 ft. from center to center between the ports, and a height of 7 ft. at least between the surface of the main deck and the lower flange of the upper deck beam are needed to work these guns properly. The 23-ton gun would require about 30 ft. between the ports, and nearly 9 ft. between the decks. Guns, instead of being fixtures, require three different kinds of motion to be provided for:—

1. Elevation or depression, for which they pivot on their trunnions.

2. Running out and recoil: in the latter the carriage runs back on the slide, being governed by a compressor, which acts like a break on a railway train.

3. Training (or directing the gun to right or left).—This is done by allowing the slide to traverse round a pivot fixed in or close to the port-sill. These three motions, and especially the third, are so much more compactly managed in the turret that a large gun does not run the same risk of breaking away as it does in the looser connection of the broadside arrangement. Some recent inventions allow the gun to be elevated or depressed about an imaginary point at the muzzle, instead of at the trunnion, thus enabling the port to be kept as small as possible, but requiring a greater height between decks. Two devices for this purpose, due to Captain Heathorn, will be seen in the case containing the turret-ships in the English marine department. The plan has not hitherto been adopted in the Royal service.

Breech-loading would very much facilitate the introduction of heavy guns into the broadside; but both the English and American Governments, after trial of the two systems, have reverted to the muzzle-loading for their heavy artillery. In this they have but repeated the experience of the early artillerists; for breech-loading weapons are nearly as old as gunpowder. It is just one of those things which have a natural attraction for inventors; but it does not appear that even the accuracy of modern mechanism has yet been able to produce heavy guns under this system which may be relied upon both for safety to the gunners and for keeping in working order, with rapid firing and after protracted use.

The French Admiralty does not as yet exhibit any large naval gun; but there is one large cast-steel breech-loader among the iron manufactures exhibited by the firm of Petin Gaudet. The calibre is 0·20 mètre, or 8½ in., while its length is 5½ mètre, or 18 ft. Some of the large Prussian guns are of the same length, or longer. Such pieces are not adapted for the broadside except in the very largest ships.

The turret system.

It is obvious that, from a port in the side of a ship, a gun

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can only command a small arc of training. It cannot be fired in a line with the keel, or even nearly so. It is, in fact, only about 30 deg. of training to the right or left that can be given in the ordinary case of a midship gun, and this not without bevelling the edge of the armour-plate at the port in a dangerous manner. To obviate this is the object of what has been variously called the cupola or turret (*tourillon*). Its most direct and complete application is when a single turret is the only projection on an unincumbered deck. Its pair of guns then command the whole horizon. But the establishment of any fixed structure on its glacis, whether it be a mast, a funnel, a raised poop and forecastle, or even another turret, detracts from its perfection, and it thenceforward competes with other systems simply on a balance of advantages. Its characteristic merits are its extended arc of training and the facility that it affords for working the heaviest ordnance. Most of the vessels actually built on this system contain two cupolas or turrets, and one or two of them contain three and even four. Many of them also carry raised poops and forecastles, and deckhouses; the tendency in the modern examples being to make the poop and forecastle very small, so as to allow of a fire either fore or aft within 10 deg. of the line of keel, and to keep the deckhouse so narrow as barely to cover the other turret. But the necessity of having a forestay and anchor gear forward, and steering-gear aft, appears to have led to the general abandonment of an absolute end-on fire. To meet this a system has been devised which is illustrated by a handsome set of models exhibited by Vice-Admiral Halsted. In consequence, however, of a wish expressed by that gentleman, I do not report upon them.

Models of French ships of war.

One of the chief defects of the turret system is the enormous displacement which it requires, ranging from 400 to 1,000 tons per gun, the higher limit being that to which modern ocean-going vessels appear to be tending.

The sea-going iron plated ships exhibited by the French Government are the following:—

*Gloire.*—A wooden liner, cut down and armour-plated along the water line, with a midship battery, also protected. Her length is 289½ ft., giving a proportion of length to breadth very nearly as 4½ to 1. She has engines of 900-horse power (nominal), and has a speed of 13½ knots. Her plating is 4¾ in. Displacement, 5,650 tons (French).

*Flandre.*—A more recent model on a nearly similar type, a trifle longer, and more heavily sparred. She has 6 in. plating, and a speed of 14⅛ knots, with the same nominal horse-power.

*Solferino.*—Plated round the water line, and having a central battery with two decks, each carrying guns.

*Alma.*—Corvette of 450-horse power, wooden hull, with $5\frac{3}{4}$ in. armour-plating round the water line and central battery. Her upper works are all iron. She is not yet launched, but is expected to have a speed of $12\frac{1}{2}$ knots.

*Marengo.*—This is a very different type from the others. She has a wooden hull with iron upper works and 8-in. armour plating. She is built for carrying 12 large guns. The armour plating extends round the ship at the water line, and there is a central battery which extends to the upper deck, and she carries above this deck, and half engaged in the bulwarks, an open armour-plated turret at each corner of the protected battery. Each of these turrets carries a large pivot gun, mounted en barbette, and capable of firing in the line of the keel, and there are four more heavy guns in each broadside. She is 280 ft. long, with a breadth of 57 ft. 6 in., and an extreme draught of 28 ft. She has a balanced rudder, curved so as to leave room for the boss of the propeller. The rigging is not brought down to chain plates outside the vessel, but is kept some 5 ft. or 6 ft. in-board, so that a perfectly clean side is presented out-board. The rigging of the other vessels is brought to the inside of the bulwarks, instead of outside; but in the Marengo there is room to stow a boat between the shrouds and the bulwarks. Her great breadth, in proportion to her masting, enables this to be done without sacrificing the necessary slope of shrouds. They are all short ships, the Marengo being the only one in which the ratio of length to breadth exceeds 5 to 1, and that only by a small fraction. There is very little gripe or fore-foot to any of them; but there is a considerable difference of trim. Hence they steer without difficulty. Their bows in general have no hollow at the water line, but run rather to a wedge than to a cusp. The point of the wedge is rounded off, in consequence of the thick stem which they carry. The Marengo has a ram bow, while the Gloire and the Flandre have upright stems.

The French vessels of recent construction have their bulwarks loopholed, for musketry.

The "Numancia."

One of the most remarkable foreign models is the Spanish iron armour-plated screw steam frigate Numancia, constructed by the Société des Forges et Chantiers de la Méditerranée.

| | | | | |
|---|---|---|---|---|
| Length | - (metres) | 96·08 | - | 317 ft. |
| Breadth | - „ | 17·34 | - | 57 ft. 2 in. |
| Depth in hold | - „ | 11·18 | - | 37 ft. |
| Draught of water | - „ | 8·33 | - | 27 ft. 6 in. |
| Displacement | - (tonneaux) | 7420 | - | 7,303 tons English. |
| Height of port-sill | - (metres) | 2·25 | - | 7 ft. 5 in. |

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She is iron built throughout, and has 5-in. armour plate, with 16 in. of teak backing from stem to stern, and from 7 ft. 9 in. below the water-line to the level of the upper deck. She is armed with 40 68-pounder guns. She is rigged as a French frigate of the second class, and her engine is of 1,000 (nominal) horse power. Her speed on her trial reached $13\frac{3}{4}$ knots. She was the first large armour-plated vessel in the Pacific. It will be observed that her stem is straight. She was built at La Seyne, near Toulon, in 1863 and 1864, in less than two years. Her screw is of uniform pitch, and gave small positive slip.

Models of the Prussian frigate Wilhelm I., the Spanish frigate Victoria, and the Sultan Mahmoud are exhibited by the Thames Iron Company. They are completely armour plated.

Several armour-plated frigates of the Italian navy are also exhibited by English and French firms. They are chiefly characterised by the excessive length of their spurs or rams.

Models exhibited by English Admiralty.

The English Admiralty contribute a complete series of half-breadth models of all the types of ships introduced into the Royal Navy since the adoption of the screw-propeller. As the English catalogue contains very full details of each of them, I think it is better not to mention them seriatim, but to give a general view of the chief changes which have from time to time been made in the leading types.

Screw steam ships of war, English.

It will be observed that they begin with wooden ships of the line, simply altered from the old class of sailing ships, by their being lengthened so as to admit of their carrying the screw-propeller and its attendant machinery, their armament being chiefly 32-pounders, with heavier guns on the lower deck, and occasionally heavy pivot-guns, none of these, however, exceeding the 95 cwt. 68-pounder. A general tendency to increase in size will be observed, especially in the case of heavy frigates, the largest and last built of these being the Orlando and the Mersey, sister ships in all but their armament. They were of 1,000-horse power, and had a speed of about 13 knots. Their length was 300 ft., their breadth 52 ft., and their mean draught of water about 22 ft. The Orlando's armament was 38 8-inch guns, of 65 cwt., on the main deck, and 12 68-pounder pivot guns, of 95 cwt., on the upper deck. The Mersey had 28 10-inch guns, of 84 cwt., on the main deck, and 12 68-pounder pivot-guns, of 95 cwt., on the upper deck.

Armour-plated ships, English.

Another general feature to be noticed is the increase in the sharpness of the lines forward and in the proportion of beam to depth and draught of water in the more modern vessels. In general, also, the lower deck port-sills are higher

out of the water, there being, on the whole, an increase of absolute size of ship as well as of weight of armament.

We pass on from these to the armour-plated vessels. It would exceed the limits allowed me for this report to do more than point out the chief characteristics of some of the more remarkable ones. The Warrior is especially worthy of notice as being the first iron seagoing armour-plated ship built in this country. Her protection is central only, and the ends of the ship are wholly unprotected. The Black Prince was built on the same lines, and the Achilles on nearly similar ones; but the Achilles has complete protection round her water-line. All these vessels have nearly the same construction of frames, which is well exemplified in their midship section. The next class is that of the Minotaur, Agincourt, and Northumberland, which have complete protection, except at the bow. Their framing differs in some respects from that of the Warrior, but they have all a common feature in which they differ from the Bellerophon and other modern ships of very large size—namely, that their flotation depends upon a single thickness of bottom-plating. The three midship sections exhibited together are well worthy of attention. The Bellerophon section exhibits all the structural superiority over that of the Warrior, which might be expected from its being built after so much more extensive experience. It has not only the double bottom, but it is lighter in proportion both to its longitudinal and transverse strength, and it is of far cheaper construction and easier execution. On comparing it with the Hercules, we observe that a certain amount of strength of form has been sacrificed for other objects, the longitudinal bulkhead of the Bellerophon evidently contributing more to strength than the smaller one of the Hercules. This sacrifice of strength is practically of no importance, as there is enough and to spare in both. In the Hercules, the object was to get an enormous increase in the thickness of the armour-plate backing at the water-line; and this was accomplished by filling up the whole breadth of the wing passage with teak, the wing passage being, of course, kept small, to prevent a needless increase of weight.

The Bellerophon is a ship which attracted a great deal of attention during the time it was in course of building. Its chief experimental importance was in the following respects:—Economy of structure, shortness of ship, combined with respectable speed, handiness and facility of steering both under sail and steam, and a heavy armament with sufficient, although not complete, protection. The most noticeable features in the model are the form of its bow and

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its balance rudder. We shall revert to these points. The Hercules is chiefly remarkable for the very heavy armour plating and backing which it is to carry; and this, as well as the Penelope, Pallas, and Research, has the peculiarity of recessed ports, to allow increased training to some of the guns.

Turret ships.

Among the vessels of the Royal Navy observable for peculiarity of form will be noticed the Penelope and Vixen, with twin screws and double sterns; and the Waterwitch, double ended, and with an hydraulic jet propeller. These are all broad, shallow vessels of moderate draught, chiefly for coast service.

We now come to the seagoing turret-ships, Monarch and Captain; the former designed by the Comptroller's Department and the latter by Captain Coles and Mr. Laird. It will be observed that neither of them has a direct fire in the line of the keel, and that, whatever their means of defence may be, they are enormous vessels compared with their means of attack.

There are several turret-vessels, like the Scorpion and the Wyvern, the Prince Albert and the Royal Sovereign, which are not seagoing ships in the ordinary sense, but are intended for coast defence. Among the broadside-ships exclusively designed for that purpose will be noticed the Trusty and the Erebus, representing two classes of floating batteries, built for the Crimean War, and now disused. The French also exhibit some nice specimens of harbour batteries and one very peculiar ram (Taureau, or Bélier), with extremely sloping sides and a single fixed turret firing two guns in a line with the keel. She is built to steam 12 knots an hour. The turret-ships exhibited by Messrs. Laird and Samuda also belong to the class of coast defence and river service. Two very remarkable boats for this purpose are the armour-plated floating batteries, Colombo and Cabral, built by Messrs, Rennie for the Brazilian rivers. They are on the "box," or central-battery system, with the stem and stern kept low, so as to admit of fore and aft fire.

The Russian Government exhibits characteristic specimens of its modern vessels of war.

1. The iron-clad frigate Sebastopol.—The chief feature of this is the absence of a forecastle, in order to leave room for bow guns in the armour-plated battery.

2. Smertch, armour-plated, with two turrets, each mounting two guns. No obstruction whatever to their fire, except what one turret offers to the other. She has twin screws.

3. Latnick, monitor, with a single turret mounting two guns.—This is the only monitor in the Exhibition.

4. Metrone Menia, armour-plated battery or ram, calculated for a speed of nine or ten knots. She has a draft of 14 ft. 6 in. Rudder and screw completely protected by the overhanging of the stern. Stem and stern fall home very much above the water-line.

The Russian Government also exhibits a wooden steam-frigate and a wooden steam-clipper, or despatch-boat, the latter calculated for 13 knots.

Austria exhibits the Erzherzog Ferdinand Max, an armour-plated vessel, which sunk the Italian ironclad Ré d'Italia at the battle of Lissa. She is armour-plated completely with $4\frac{3}{4}$ in. plating.

Sails and rigging.

The means of propulsion employed for the iron-clad ships-of-war is a matter of very great importance, and is fully exemplified in the different models, both as proposed and as actually carried out. There seems to be a general consent to give them what is called jury-rigging—that is to say, much shorter and slighter spars and smaller sails than would be used in sailing ships of the same tonnage. The English Admiralty exhibits no rigged models; but the Wilhelm I., the Sultan Mahmoud, and the Victoria, fine vessels exhibited by the Thames Ironworks, will show the rigging usually adopted. The French navy is rigged on the same system, but with the precaution of keeping the standing rigging well in-board, by putting the chainplates in the deck inside the bulwarks instead of outside.

America exhibits very little in the way of naval architecture.

Merchant steamers.

There is ample illustration of the merchant and passenger steam service, both of England and France, and of steam yachts and transports. I cannot attempt to enumerate these, nor do I observe any such marked peculiarities as would justify me in selecting any of them for special remark. It appears to me that a marked improvement has taken place in the naval architecture of Europe, not so much in any one strong feature as in a general tendency to advance in the perfection of form, fitness, and convenience, and external beauty. There is much less of extravagance of design, or idea, whether displayed in form or mechanism, and much more practical appreciation of structural beauty than I have observed in previous exhibitions, or than is to be seen here in some of the older designs.

A very valuable historical series of models of merchant-ships is contributed by Messrs. Normand, of Havre. I studied with great interest the way in which the progress of shipbuilding exhibited itself in the practice of an old established house. We see here the gradual expansion in mag-

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nitude, and the steady gradation of form from the old model of 1735, to the newest types of the present day, not masked by the varying practice of different firms, but just as it imprinted itself on an establishment with traditions already settled.

The Danube Navigation Company sends a very fine collection of models of its paddle-wheel passenger steamers, cargo-boats, cattle-boats, and lighters. They are very long and shallow.

Norway, also contributes good models of the vessels built in the Bergen district by Mr. Jens Gran and Mr. Dekke.

Form of ships.

*Form of Ships.*—Many theories have been advanced as to the forms best calculated for speed, for stability, for easy rolling, and for almost every conceivable quality or combination of qualities which a ship may be imagined to possess. Yet the actual design of a ship's lines has still to be done empirically. Our theories and our calculations give us limits only, not form; for this we are still dependent on taste and experience. Our science enables us to control and correct our result; but our theories are yet too crude for the pure application of any one of them to produce a good ship. But we have arrived at very good approximate theories; and although it is certain that no two naval architects would produce identical designs for the same object, as they would on an exact theory, yet there is a very well settled type for most of the leading forms of vessels from which few modern designers appear very much to depart.*

For the large ocean-going steamer the midship section generally shows a flat floor, and a full, or even square, bilge, with a high co-efficient of fineness. The length is seldom less than seven times the extreme breadth. On the water line there is more or less of straight middle, as the necessities of the service appear to require. The horizontal sections of the bow are generally what are known as Scott Russell's wave-lines, but usually a little coaxed out of their extreme sharpness towards the stem. They are almost always kept hollow in English ships; but the constructors of the French navy do not believe in hollow lines, and make but little use of them. With regard to the bow sections on the body and sheer plans, a great uncertainty, which seems, at last, to show signs of settling into something definite, appears to have lately prevailed; and the recent history of this is very well elucidated at the Exhibition. The Orlando and Mersey frigates, the

The bow.

* In speaking of the lines of a ship, the part which is immersed in the water, either permanently or occasionally, is chiefly considered. The upper works do not commonly enter much into this part of the discussion.

Himalaya troop ship, Her Majesty's yacht Victoria and Albert, and the armour-plated ship Warrior, are very good specimens of different kinds of bows with the cut-water or "knee of the head." Then come the Achilles and Minotaur, with bows very nearly vertical, but a slight projection of the stem near the water-line. We then come to what has been called the U bow, seen in the Pallas, Bellerophon, Lord Clyde, and Amazon. This had the advantage of giving a large displacement far forward, so that the weights at the bow were better water-borne than in ship with overhanging bows. But these vessels carry a large wave before them, which interferes with their speed, and is in other respects inconvenient. Accordingly, the more modern designs of the Hercules and the Monarch have nearly vertical bows. The stem projects as a ram, but immediately behind the stem the bow is vertical, the bulwark acquiring a little flare as we go back towards the cat-head, and then again becoming vertical before it begins to tumble home in the neighbourhood of the midship section. The U bow will be seen in excessive development in some of the foreign navies, as in the Maria Pia, exhibited by the Compagnie des Forges et Chantiers de la Méditerranée, and in some of the armour-plated vessels specially constructed as mere rams.

The bows of the Solferino and Marengo (French Imperial navy) are worth special study. They are rams, and they secure a large displacement forward by falling home, above and below, from a point considerably below the water-line. But this object is attained in a way quite different to the U bow as seen in the Pallas, the forefoot being very much rounded off in the Solferino, and cut away so as to form a re-entering curve in the Marengo, so as in both to leave as little gripe as possible. The French ships are generally short and have a considerable difference of draught, as is also the case with the Pallas, the Favorite, the Bellerophon, and the Hercules.

The stern.

Sterns of modern ships are generally constructed with a much finer run than was usual in former times. It is also usual in iron-clad ships to make their horizontal sections, at and above the water-line, in the form of an ogival or Gothic arch, instead of the elliptical or square forms seen in merchant ships and transports; the object, of course, being to get more complete protection for the screw and rudder, without too great resistance or weight. In the case of twin screw-ships of large size, like the Penelope, there are two distinct sterns, one carrying each screw, with separate deadwood and rudder; the space between being arched over. There is thus a considerable length aft but very imperfectly water-borne.

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The upper works.

The upper works of ships exhibit a far greater variety than the underwater body, their design receiving but very few limitations from the hydraulic problem. The modern tendency has perhaps been to keep them too low both in armour-plated men-of-war and in cargo vessels. The topgallant poop has long since disappeared, and a flush-deck is quite common, with sometimes a small poop and an open forecastle. In passenger-vessels a spar-deck, or a long deck-house, extending from the poop to the forecastle, and leaving a long gangway on each side from 5 ft. to 8 ft. broad along the middle portion of the ship, seems likely to become the normal type for seagoing steamers. This has the advantage that there is less broken surface, which is better for strength and also as offering less resistance to the air. The last consideration is too often overlooked, although it is of one of great importance when a vessel has to be driven at high speed in any direction but that of the wind.

Several specimens of the saloon-ship are exhibited, and Messrs. Randolph and Elder have a model of one of the fine steamers they have constructed for the Pacific, with two saloons, one over the other, above the true upper deck of the ship. In the stormy waters of the Atlantic such vessels, although freely used by the Americans, do not find favour with the English, who regard them as inconvenient, if not dangerous.

Composite ships.

*Composite Ships.*—Lloyd's Registry contributes a very fine series of drawings elucidating their proposed suggestions for composite vessels. The principle chiefly apparent in it is to secure a cage, or skeleton of iron, complete in itself in every respect but that of keeping out water. The wood planking then converts it into a ship. The principle involved in this is very important, and depends on the observation that iron and wood together are not generally to be depended upon for helping one another to meet a single strain beyond the strength of whichever of them is separately the strongest. Each material therefore must be kept to its own work. Besides this principle, there is a vast amount of minute structural detail involved in the compilation of such a set of rules as have already been adopted by Lloyd's and other registries for wood and iron vessels separately, and are now proposed for composite ships.

Bolts for armour plating.

*Bolts for Armour-plating.*—Armour-plates and ordnance belong to a different class, which I have not been charged to report upon; but the mode of fastening it on is a part of ship-building, and the bolts adopted by the French are worth noticing. The hull of their vessels being of wood without any inner lining, there is no proper bed for a nut and bolt.

They therefore use wrought-iron screws, which simply hold in the wood like common carpenter's screws. They have a small raised thread forged on them with a pitch of about $\frac{3}{4}$ in., and consequently a flat space of about $\frac{1}{2}$ in. between the consecutive turns. It is not turned, but forged with an anvil and a hammer, having each three turns of the screw, the workman who holds the bar giving it a slight twist at each blow. The longitudinal fibre of the iron is thus unbroken, as M. Tresca has shown by oxydising a section of such a screw. The French officers speak very highly of their holding power.

Sheathing.

*Sheathing.*—Several methods of sheathing iron ships are exhibited, involving three or four different principles. It may be premised that the object of sheathing an iron ship is not, as many suppose, to prevent general corrosion, but to prevent fouling. Now copper, and, in a less degree, yellow metal, has this quality, that instead of corroding unevenly like iron, it goes almost uniformly over the whole surface, and that the salts formed by the action of the sea water are soluble, so that it remains constantly smooth and slippery. It is this peculiarity, and not its poisonous character, that prevents seaweed and marine animals from adhering to it; for, when protected galvanically, it fouls as quickly as iron, wood, or stone. Many inventors have therefore endeavoured to find some means of getting copper on to an iron ship in such a manner that the iron shall be effectually insulated from it, and not form a voltaic couple, which would protect it at the expense of the iron. In the English annexe, Mr. J. H. Ritchie, jun., Mr. Mulley, and Mr. James show different methods of effecting this. Captain Roux, of the French navy, also exhibits a very elaborate process for obtaining the same result. The Inconstant, exhibited by the Admiralty, is another experiment in this direction. The object in them all is to secure complete insulation between the copper and the iron, and also to keep the iron completely covered up by the sheathing. They are all very expensive methods, and complicated too; and they have all this disadvantage, that any external injury which exposes the iron and breaks the insulation, causes rapid local corrosion, so as to eat holes in the ship's side in a very short time.

Mr. Daft takes an opposite method; he sheathes with zinc, so that the voltaic action of the iron may cause this sheathing to undergo regular corrosion, like that of copper on a wooden ship. He exhibits experimental specimens by which its effect may be seen. His mode of putting on the sheathing involves a serious change in the present method of constructing iron ships, which will certainly hinder its imme-

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diate adoption. Mr. Hay and Mr. Gisborne exhibit paints or compositions to prevent fouling and corrosion.

Rigging.

*Rigging.*—There is very little exhibited of detailed arrangements relating to the masts and sails. There is one English plan for reducing topsails by rolling the yard; and there is also a French topsail exhibited by Captain Frémont, which is said to be in general use in ships hailing from Havre. A light extra yard, or batten, with a tye of its own, is laced across the sail, at a little more than half its height. To reduce sail, the proper topsail-yard is simply lowered upon this. The yard may then be manned and reefs taken and secured in the usual way; after which, if it is only to be single reefed, the yard is again hoisted. Mr. Cunningham also exhibits his patent chain braces,

Propellers—the screw.

*Propellers.*—For large ships of deep draught the screw propeller seems to be almost universally adopted, and is to be seen in every variety. When used as an auxiliary, it is, in English practice, either lifted, or disconnected from the engine and allowed to revolve freely. But the French not unfrequently use a double-bladed Mangin screw with narrow blades, and fix it in a vertical position, so as to be sheltered by the propeller-post. They find that in this position it offers but little resistance to the water, especially in wooden vessels, in which the propeller-post has a considerable breadth. It is shown in the transport Creuse, exhibited by the French Government. Feathering-screws appear to have been generally discarded.

The propeller is now very commonly supported on a single bearing, especially where there is a balanced rudder, and large bosses are now generally seen. In English practice, the boss is usually spherical; but in the Marengo the French constructors taper the after part of it to a point, probably to prevent the accumulation of dead water. In this case the screw-shaft has two of Hooke's joints between the engine and the coupling, to allow for the deformation which may take place in a wooden ship.

Twin screws.

The twin-screw does not yet appear in vessels of very large size, but it appears to be almost universally adopted by the English in small vessels of light draught. All our steam-launches use the double screw; while the French still adhere to the single screw for these, and work them with a single cylinder. There is an advantage in the very simple engine which they put into these little vessels, all of ours having two cylinders, and some four; but the twin-screw seems better than a single one for such small craft. Very nice specimens of the regulation steam-launches are exhibited by M. Claparéde and the Forges et Chantiers de la Méditer-

ranée for the French navy, and by the English Admiralty for our own. The latter has Maudslay and Co.'s four-cylinder twin-screw engines of six-horse power. Messrs. Penn and Messrs. Rennie also exhibit engines for launches, the latter with surface condensers.

Jet propeller.

The Waterwitch, armour-plated steam gun-boat, is remarkable for having a hydraulic or jet propeller. She takes in the water from the sea through a sort of sieve in her bottom. The water is then taken up by a turbine-wheel or centrifugal pump driven by steam, and thrown out in a backward direction, with considerable velocity, through trunks in the side of the ship. The ship is propelled by the mere reaction of the water thrown aft, the principle being exactly identical with that by virtue of which a boat is pushed forward by a man who jumps from her stern. She is double-ended, with a rudder at each end. The propeller is reversed from the deck by turning a sort of huge three-way cock, without reversing the engines. A speed of 8·8 knots has been attained by this vessel, although her form is not suited for high speed. There exist no data for comparing her performance with that of the screw; for, although it has been frequently stated in certain newspapers that she is a sister ship to the Viper and Vixen, a comparison of the two models (which are close together) will show that, although their extreme dimensions are not very different, their lines are so wholly dissimilar as to render any comparison very uncertain, if not illusory.

Other propellers.

Lieut.-Colonel Evelyn exhibits a model of a yacht with an oblique propeller, consisting of a flat plate sliding on an upright post. The plate is pivoted on a frame sliding on this post, so as to allow the after edge to rise or fall until it reaches a stop. The machinery simply drives this plate up and down the post, and the reflection of the water from the oblique surface, or, what is the same thing, the resolved thrust aft, drives the ship forward. The plate reverses itself by means of the resistance of the water as the stroke changes, and thus the resolved thrust is never forward. There is an arrangement to get steering power by turning the post on which the propeller slides, so as to deliver the thrust to port or starboard, instead of right aft.

A screw-propeller is also exhibited, driven by a horizontal wheel and bevel gear. The inventor considers it to be adapted for vessels of shallow draught.

M. Guerbigny-Germeuil exhibits a direct propeller, consisting of a vertical plate driven right aft, and canting edge on for the back stroke. By means of a lazy-tongs arrangement the propeller has five times the stroke of the engine, which

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is direct. Each propeller has 32 distinct bearings and two slides, which come into play at each stroke. There is thus a good deal of friction.

General principles of propulsion.

With regard to these and any other inventions about propulsion, it is useful to bear in mind the following considerations:—

1. That almost any propeller will give more or less propulsion to almost any ship.

2. That the object therefore is not merely to effect propulsion, but to obtain better performance than is already got by the paddle and the screw, which have a very high performance.

3. That small models are under wholly different conditions from full-sized ships, not only in respect of what is mechanically possible, but in respect of the comparative values of the different elements of power and resistance which enter into the calculation.

4. That, in general, all propellers drive their vessels simply by the reaction of the water thrown backwards from the propeller, and that their falling off from theoretical efficiency is due to this being wastefully done; that is, to the machinery having to do something more than simply to throw the water aft as quietly and quickly as possible.

Steering—effect of rudder.

*Steering Gear: Rudders.*—A rudder may be considered under two aspects, as giving roughly an approximation to a curved keel, or as a mechanical engine for turning a ship by means of that portion of the effect of the impact of the water upon it which can be resolved at right angles to the keel. The latter is the more convenient for measuring the force, the former is sometimes simpler for getting at the effect. The combined effect of increased length and lateral resistance, and of the tendency of the screw to sweep away the dead water which otherwise would hang round a large portion of the rudder, renders the work of getting over the helm of a modern screw-steamer far greater than that of steering an old-fashioned sailing ship. In the Messina, $2\frac{1}{2}$ tons, at a leverage of 1 ft., were required to bring the rudder over to 40 deg. when the ship was going nine knots an hour. The Messina is not equal either in length, draught, or speed to many of our more recent vessels, and the enormous turning power required has led to the necessity of mechanical expedients to relieve it. A long tiller, with a purchase, was the first idea, a steering-wheel the next; but it is obvious that any method of applying a sufficient twisting force to the rudder-head will answer the purpose, so long as the rudder-head stands. To obtain this force is simply a question of mechanical work, and the whole of the exhibited

steering apparatus may be described as simply different methods of applying this twisting couple to the rudder-head, until we come to the balanced rudder, which involves an entirely different principle.



Steering gear.

Messrs. Huxhams and Brown exhibit a cross-threaded screw—that is to say, a screw with two threads, one right-handed and one left-handed, crossing one another. This works in two half nuts, one of which is fixed to each end of a short lever, which turns the rudder. The half nuts pass one another along the screw, being opposite when the helm is amidships. Messrs. R. Napier and Co. and Messrs. Denny and Co. exhibit two arrangements, differing only in detail, in which a right and left screw works two nuts, from which connecting rods pass to the cross-head of the rudder. A French exhibitor, M. Artige, produces one which differs from that of Messrs. Napier chiefly in being heavier. Mr. Skinner's vertical steering apparatus has a cross head working up and down by means of a screw of low pitch in a fixed slot, which is shaped as a screw of high pitch, so that as the cross-head moves up and down, the fixed screw slot twists it and turns the rudder along with it. Mr. Hewitt exhibits a rudder which turns by spur gear, working on a spherical boss. Denny's apparatus took five complete turns of the wheel to bring it hard over.

Lumley's rudder.

Lumley's patent rudder consists of two pieces hinged together like a folding door. There are various contrivances for making the two parts move together in such a way that the outer part shall make the same angle with the inner part as that does with the ship. There can be but little doubt that the principle is a good one, subject to the difficulties of increased friction and complex gear, with its attendant risk of derangement. The after part is less rigidly connected with the ship, and may thus run some extra risks; but this circumstance appears conducive to the safety of the rudder as a whole. Its chief objection lies in its complexity.

Balanced rudders.

All these methods have more or less tendency to strain the rudder-head, and therefore some of our modern naval architects have reverted to the balanced rudder, in which a portion of the rudder is forward of the pivot. In this way it is possible to get rid almost entirely of the twisting strain, so that a child may turn a very large rudder. The chief objection to it is the difficulty of securing it. The principal support is at the neck, and this is in general but insufficiently aided by a pivot resting in a horizontal plate projecting aft from the keel. There is generally no rudder-post, and no after bearing for the propeller shaft. The Bellerophon and Hercules are thus fitted, and the French

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ship Marengo. In the latter, the forward edge of the rudder is scooped out to allow room for the projecting point of the boss of the propeller, so that the balance of the rudder is got chiefly at the neck and heel. Another form of balanced rudder will be seen in Admiral Halsted's models. In this there is a rudder-post, which gives an after bearing to the propeller, and half-way between the upper and lower points of support an arm projects from the sternpost so as to give an intermediate bearing.

Torpedoes.

*Vessels for Special Purposes.*—A model of a very remarkable submarine torpedo-boat is exhibited by the French Government. It is a very long and sharp vessel, carrying a pole with a torpedo at the end, which it is intended to deposit under the bottom or against the side of the ship which is to be attacked. The motive power is contained in three cylinders of wrought-iron, containing air enormously condensed. This works a small screw-engine, and, after having done its work in that, is allowed to escape inside the vessel for the supply of the crew. There is the usual vertical rudder for giving horizontal direction, and there are horizontal rudders for giving vertical direction. There is also a little apparatus for altering the displacement sufficiently to bring her to the surface if required, and a little life-boat, so contrived that the crew can leave the vessel by it in case of danger or accident. The vessel is in existence at La Rochelle, and it is said that it has actually remained three hours under water. But, from some cause or other, it does not seem to be regarded as of practical utility.

Dredges.

Steam-dredges and mud-barges are exhibited by Messrs. Rennie and Co., and several other English makers. A very interesting set of these is also to be seen in the collection relating to the Isthmus of Suez.

Floating Docks.

Floating docks are exhibited by Messrs. Randolph and Elder, who show a model and drawings of the one they constructed for the French Government at Saigon; and by Messrs. Rennie and Co. Mr. Edwin Clark's fixed hydraulic lift is also exhibited. In the Netherlands division will be found a model of a camel for floating ships over shallows.

Messrs. Rennie exhibit their hauling slips for the repair of ships. A very ingenious arrangement for this purpose is exhibited by M. T. Labat, of Bordeaux, by which ships are hauled up broadside on.

M. Bertora exhibits an "enveloppe imperméable," which is a sort of mackintosh bag to keep all dirt and weed off a ship when laid up in harbour. The difficulty of getting the bag on, added to the prime cost, makes it a very doubtful economy.

Two arrangements for firing guns under water are exhibited. The principle in both appears to be to have a hole in the ship's side, guarded by a sluice valve, and having an elastic collar, which grasps the muzzle of the gun. I was not able to make out clearly what provision there was for keeping out the water on the recoil of the gun until the sluice valve could be screwed home; nor could I discover any arrangement for taking aim. Firing guns under water.

*Yachts.*—The French Government exhibits models of the Imperial steam-yacht Aigle, and of Prince Napoleon's yacht Jérôme Napoléon. The English Admiralty exhibit their own yachts, Black Eagle, Elfin, and Investigator, and the Royal yachts Victoria and Albert, Osborne, Fairy, and Alberta. Messrs. White exhibit a paddle steam-yacht, designed for the Egyptian Government. Of sailing yachts, several are exhibited by some of the best known English and French builders, although we miss some well-known names, I do not find the materials for a detailed report in what has been exhibited; for among sailing-yachts the differences are so minute that a race upon equal terms is almost the only effective comparison. I note, however, an increasing divergence of the racing and travelling types. Yachts.

*Fishing-boats* are so much mixed up with pleasure-boats and small coasters that a report on one class alone would be very deficient. I, therefore, permit myself to call attention to the very complete set of this species of craft which is to be found in the Norwegian and Swedish exhibitions. It is especially interesting to an Englishman, from the large inheritance of Norse tradition which we possess, especially in these matters. But they fall within class 49, and will, therefore, I presume, be the subject of a different report. Fishing-boats.

*Lifeboats.*—The well-established type of this class of vessel is the regular boat of the Royal National Lifeboat Institution of England. This has been extremely well considered and approved, after great experience under almost every possible combination of circumstances; and it is probable that, for general purposes, there remains but little that could be altered with advantage. One of the best proofs of this is that the French Shipwreck Institution has adopted it without any change whatever, except in the carriage on which it is mounted. But a good boat, like a good ship, is to so great an extent a compromise of many qualities more or less sacrificed to others, that there is ample room for advantageous deviation, to suit special circumstances, in many directions. In this way there is much to observe in the models of lifeboats, and of boats partially fitted as lifeboats. Many of these possess the combination best suited to their requirements. Lifeboats.

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One of the marked peculiarities of the society's typical lifeboat is that of righting itself when capsized. This is one among the least valuable of a boat's qualities, and interferes very much with its carrying power, either for wrecked passengers or for general use, as it depends upon having high air-cases at the bow and stern and a heavy iron keel. It is consequently abandoned without hesitation in favour of other qualities in paddle-box boats, and in the lifeboats of emigrant ships. In the man-of-war's lifeboat the air-cases are made removable at will, by simply unscrewing an iron strap; so that the man-of-war has thus a good useful whale-boat for general rough weather, and also a self-righting boat for sending out a small crew where a boat is liable to unusual risk of upsetting. For an emigrant ship, on the contrary, it is clearly better to trust to the boat that will hold most people without upsetting. Accordingly, Mr. White, of Cowes, exhibits nearly every description of life boat except self-righting ones, and a very instructive collection his set of models will be found. The Life-boat Institution also exhibit their sailing lifeboat for Norfolk and Suffolk. The wrecks on these coasts generally take place on the outlying sands, and not on the shore, and the crews are generally taken off by the lifeboat from the port to windward. These boats have neither the high air-cases nor the excessive sheer of the row-boat, and do not right themselves; but they have the same means of clearing themselves of water. The society also exhibits two models of fishing-boats, with weather-tight hatches instead of decks, and subdivided into compartments. The terrible loss of life that has arisen from the almost exclusive use of open boats for the fishermen of many of our ports shows the necessity of some covering to keep out the water. The division into compartments is a secondary feature, which is not without its disadvantages, being dirty for small vessels; but a longitudinal bulkhead certainly diminishes the risk of capsizing. Among the French boats, besides the one exhibited by the Société, there is an iron life-boat from Havre, which is built on a model not unlike the ordinary English one, and has seen a good deal of service. There is also a very peculiar one, called the Prince Jérome No. 2, from Havre. A German lifeboat, also on the *berge* is very like our own. Mr. Devrient, of Dantzic, exhibits an excellent sailing life-boat, with air-cases. There is also a model of a life boat from America, which is said to have done good service. Among the curiosities will be seen a model of Greathead's original lifeboat, and of Richard's tubular lifeboat or raft. The defect of all double boats or rafts is that they will not turn to windward.

*Pleasure Boats.*—My report upon these must be very short indeed, for the reason that there is very little exhibited that has any claim to striking novelty, except a few vagaries. There is both improvement and selection visible in the models presented, but the only marked novelty is the canoe with the double paddle, and the small steam pleasure-boat. The latter is simply a small edition of the steam-launch, and I have seen one or two of them at work on the Seine. I doubt not that they will be found extremely serviceable for much other work besides pleasure, and the small lake steamers from Sweden are a practical proof of the utility to which this system can be turned. The canoe is exhibited in two forms by Messrs. Searle—as the racing canoe, and, according to the latest improvements of Mr. M'Gregor and the Canoe Club, as a travelling canoe. For a full description of it I must refer to Mr. M'Gregor's published works. Its chief feature is the use of the two-bladed paddle, a right and left stroke being given alternately. Its disadvantages are, that it throws a good deal of fatigue on the back of the canoe-man, while it does not bring the dorsal muscles into full play to assist propulsion. The work thus comes chiefly on his arms. His hands also suffer from the wet running along the paddle, in spite of the ring used to stop the water. It has some very important advantages in the narrow waters for which it is contrived—that it can work in narrow openings which a row-boat could only shoot or pole through, and that the rower looks at his work. This has its value in intricate navigation.

Pleasure boats.

I would give a caution to some of our holiday seekers to be careful how they risk themselves at sea, especially on our western coasts, as they might be tempted to do, by the excellent qualities of these canoes. In the hands of an experienced canoe-man, who is also thoroughly acquainted with the coast, a great deal can be done with them; but a solitary person, in any kind of boat, is not safe on the edge of the Atlantic, unless he thoroughly knows the pilotage. The fact is, that the propelling power at the command of one man is not sufficient for the wider waters, unless under the exceptional circumstance of calm weather, and this is often treacherous.

Caution in use of canoes.

It is sometimes amusing to see the curious expedients which are continually being invented to save the trouble of looking over the shoulder occasionally when rowing a boat. There is a contrivance in a shed on the *berge* with this sole object. The inventor puts up a post in front of the rower to which the in-board ends of the sculls are fixed, and then there is a complicated arrangement of brass rods and spiral springs, which enables him to work his paddles the reverse way, with some attempt at feathering.

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There is a caique from the Levant, with its oars heavily loaded in the loom. These boats are said to pull very fast.

Boat gear.

*Boat Gear.*—The French shed on the *berge* contains a great variety of yokes, tillers, rowlocks, tholes, crutches, horses, belaying-pins, cleats, sheaves, eyes, and other boat and yacht gear. In some of them the strength of the fastenings did not correspond with the scantling of the piece, but generally they seemed very well adapted to their purpose.

The exhibition of boating clothes was wonderful to behold. It is clear that the Parisians do not neglect the decorative part of seamanship.

Boat lowering gear.

*Boat-lowering Gear.*—Clifford's well-known method is exhibited. There is also a very simple arrangement for the same purpose in the American division (by Messrs. Brown and Level). Both falls are of the same length, and are brought to one winch on board the ship (not the boat), the falls passing between flat pulleys, which thus grip them until both ends run out together. Mr. May exhibits one on a different system in the English annexe. In this the falls are liberated simultaneously by means of a trigger.

On the whole, I regard the exhibition in class 66 as very interesting and instructive, but very far from complete.

## Report on Lighthouses and Coast Illuminators.—(Class 66.)—By Captain M. C. Close (Trinity House).



In the necessarily-contracted space to which a report on the lighthouse department of France and England, as shown in the Universal Exhibition of Paris, is restricted, many objects of interest may only be enumerated, and much interesting detail of those reported on will have to be omitted.

### France.

French lighthouse in park.

The handsome iron lighthouse, erected on rockwork, nearly surrounded by water, on the left of the park entrance from the Pont d'Jena, is to be placed on a dangerous reef off the north coast of Brittany called the Roches Douvres rocks, situated about equi-distant from the islands of Brehat and Guernsey, and about twenty-seven nautical miles from the port of Portvieux. It will stand on the south side of the middle of the reef. The basement of the masonry on which it will be placed is on a level with high-water spring tides, and will be carried up 2·10 metres. The height to the summit of the lantern is 56·15 metres; its diameter at base is 11·10 metres, and 4 metres at the top beneath the lantern gallery. The focus of the light will be 53 metres above high water. The tower is peculiar and elegant in form; the peculiarity of its construction is that its powerful framework is independent of the outer iron coating, so that any portion of its plating may be removed or changed without in any way affecting its strength, enabling, moreover, easy inspection of its plates. It also has the advantage, during erection, of dispensing with all scaffolding, and combines great strength with lightness and economy, the complete building (including the cost of erection, &c.) costing only 10,000*l*. The tower contains, beside coal-bunker and oil-tanks, a kitchen and three keepers-rooms, and a room for the inspecting engineer. It is surmounted by a first-order revolving light, giving a bright flash every four seconds, the eclipses being nearly double the duration of the flash, which is prolonged by a peculiar arrangement of the upper and lower prisms. The apparatus consists of a polyzonal cylinder of twenty-four sides; the dioptric lens and the two catadioptrics of each face have their axes in the same vertical plane; they have a horizontal divergence of 6 deg., and their maximum intensity is reckoned at 2475 flames. The revolving machinery produces an entire

Capt. Close on Light-houses and Coast Illuminators.

revolution in 1 min. 36 sec. M. Léonce Renault, Chief Engineer of the Ponts and Chaussées, and Mr. E. Allard are the engineers, and M. Rigolet the constructor.

Lenses.

The following lenses are shown in the building, viz.:—

1. A first-order fixed lens, varied with sixty-seconds flashes from a second-order polyzonal lens, the whole revolving; the sections of the frame and lens of the fixed light being projected in advance of the revolving light in proportion as the diameter of a first-order frame is greater than that of a second order. The idea is to equalise the light from the revolving and fixed lenses by increasing the fixed as a first order and diminishing that of the revolving one as a second order.

2. A lens of alternate flashes and eclipses at intervals of sixty seconds. It is 0·70 in. in diameter, a size between the third and fourth order. It consists of eight polyzonal lenses, with twelve prisms above and four below. The central zone, or polyzone, has six rings; the light is focussed in this lens by means of a long spiral screw from the base of the pedestal to admit of it being used for an electric light. Two of the eight sections open for trimming, &c.

3. A section of a third-order light fixed, with shutters outside the lens working from right to left simultaneously by clockwork machinery, creating eclipses in the direction of danger. The machinery and arrangements appear very simple. This apparatus is fitted with revolving machinery.

4. A first-order revolving holophotal lens, of twenty-four sections to the circle, similar to the one already described for the Roches Douvres. The glass, both in colour and finish, is very good. The supports and framework of the lower portion are of brass, which makes it costly without increasing its strength. Intended for America. Made by Barbier and Co.

The second lenticular electric apparatus exhibited produces different periods of light. Both are revolving. The first prolongs the flash, and thereby reduces the period of the eclipse, the lenses being placed so as to give a greater divergence than is generally the case, and to avoid as much as possible all vertical divergence, to effect which recourse has been had to the system of double lenses, such as are seen in the Calais and some other French lighthouses. Each of these lenses consists, in the first place, of a sixth-order fixed light very well made, with the prisms as small as possible to avoid thickness of the glass.

Around the lower fixed lens a six-sided apparatus revolves, each face consisting of a central section of a cylinder, about 30 deg. wide, and the full depth or height of the fixed apparatus. On each side of this central piece are fixed, parallel with it, three refracting prisms, each of the three

comprising about 15 deg., thus making each entire face about 60 deg. By focusing each panel about $\frac{1}{4}$ in. beyond the light a greater degree of divergence is given than would be due to the size of the light; this divergence is about 6 deg., consequently each flash should be ten times as bright as a fixed light of the same power as the one employed. The outer apparatus revolves in seventy-two seconds, giving a flash every twelve seconds, and the light interval is to the dark as 1 to 10.

The upper lens has around it a revolving apparatus, consisting of eighteen very thin sections of a cylinder of 20 deg. wide, each without any prisms. The side next the light in these, as well as those in the lower lens, are plane surfaces—the outer only is curved. The focus of these as of the others is behind the light, for the purpose of giving extra divergence. In these the divergence is 5 deg., with a flash four times as strong as the fixed light; and the proportion of time between the duration of the flash and the darkness is as 1 to 3. The revolving part of this upper lens turns with the same velocity as the lower, which gives a flash every four seconds.

Drawings of the various lenticular apparatus are exhibited in the lighthouse.

The intensity of the flashes is considered to be as follows, viz.:—

| | | Flames. |
|---|---|---|
| The flash light - - | from minimum | 13,500 to 20,000 maximum. |
| The fixed light - - | „ „ | 5,000 to 5,000 „ |
| The fixed light, with flashes | „ „ | 49,000 to 73,000 „ |
| The 30 sec. eclipse light - | „ „ | 10,000 to 15,000 „ |

It is thought these intensities may be doubled by putting both steam-engines in motion.

French harbour lighthouse.

A type of the harbour lighthouse adopted by France is shown on the banks of the Seine. Its height is 8 metres from the base to the platform gallery; diameter at base, 1·71 metres; and at the summit, 1·49 metres.

It is octagonal in form, of T-shaped iron mountings, bent to the desired angle and covering the joints. Its cost is 360*l*. The illuminating apparatus is composed of six annular lenses, partly dioptric and partly catadioptric, producing a flash every twenty seconds. Colza, petroleum, or schist oil may be used in these lenses. The flashes alternate red and white. M. L. Renauld and E. Allard, engineers; and M. Rigolet, builder.

Models of lighthouses.

Among the models of this department are the following:—

3. The lighthouse of Triagoz is represented by a model in relief. It is a third-order light, situated on a rocky island to the east of the Sept Isles, in the Channel. It consists of a square tower; on the basement is a vestibule with store-

Capt. Close on Light-houses and Coast Illuminators.

rooms and three keepers'-rooms, the roofs being vaulted; and it has an external gallery. The building was commenced in 1861 and completed in 1864, at a cost of about 12,000*l.*

4. Phare de la Banche, began in 1861, finished in 1865, is situated to the south-east of the entrance to the Loire, about 9·500 metres from the land. The height of the building is 26·525 metres, and the focus of the light 21·225 metres above high-water spring tides. The cost of the work amounted to nearly 13,000*l.* Built under the superintendence of M. Chatory and Messrs. Lalley and Britat.

5. This model represents a lighthouse, erected in 1865, in New Caledonia; it is of iron, and in nearly all respects analogous to that of the Roche Douvres, which renders a detailed description of it here needless. It was constructed under the same engineers as the former one.

Drawings of lighthouses.

The following are drawings of various lighthouses, either completed or in process of erection:—

Phare du Créach, established on a reef of rocks lying off the west point of the island of Ushant. The tower is 43 metres high, built of the stone of the island, pointed with Portland granite, and was completed in 1863, at a cost (lens inclusive) of upwards of 14,000*l.* M. Matrot de Varennes is the chief engineer.

Phare de Conti, mid-distance from Arcachon to Biarritz, on a sand-hill surrounded by a sandy desert, rendering the construction of it a matter of great difficulty. It cost upwards of 7,000*l.*

A drawing claiming attention is that of the lighthouse of Cape Spartel, at the entrance of the Strait of Gibraltar, on the shores of Morocco, at a spot where the Brazilian frigate Dona Isabel perished with her crew in 1860.

Lightship.

Many other interesting drawings of lighthouses are exhibited.

As for the floating lights, there is a model of lightship moored in the roadstead of Dunkerque, called the "Ruytingon" Light. It is built nearly on the lines of our English floating lights, and has little deserving special notice. Its cost was about 5,000*l.*

Buoys.

With regard to the models of buoys exhibited by France, the first four numbers represent beacon buoys, the fifth a mooring buoy. They are made of iron plates on an iron frame, divided into water-tight compartments, so that, should a plate be damaged or become leaky, the buoy would heel over, but the air-tight compartments prevent it sinking. These buoys, both in form and construction, resemble those in use in England, the report on which will serve equally for either. This applies also to the bell buoys.

Beacons.

Model of a beacon on the Antioche Rocks, Isle of Oberon, consists of four iron cylinders carrying a square iron cage, surmounted by a pyramid, intended as a refuge from shipwreck. Cost about 800*l.* Executed by Mr. Beaucé under M. Leclerc.

A tour balaisé for sea mark and saving life has a tide-gauge and beacon, also a bell rung by the motion of the sea acting on floats. Erected April 20, 1865, in the Isle of Noirmontier; also in use off Rochelle. The bell and machinery by M. Foucault Gallois, of the Isle of Ré; built by M. Forestiér.

## England.

English lenses and lights.

In class 66 of the English section of the Paris Exhibition, in the very limited space afforded for exemplifying the lighthouse illumination of Great Britain, the Trinity House authorities contrast some beautiful modern lenses with a ponderous old bull's-eye lens, made by Cookson, of Newcastle, which, in spite of the green colour of the glass and workmanship, coarse as it looks when compared with the high finish and sparkling appearance of those of the present day, still did good service for many years, having in its turn succeeded the patched old metal reflector that had taken the place of the beacon fire about a century.

With whom the first idea of the built lenses, on which those of the present day are merely improvements, originated is, and probably ever will be, a disputed point. Sir David Brewster and Condorcet both lay claim to priority of invention; but there is little doubt that M. Fresnel was the first to produce a lens built of separate pieces of glass, at the suggestion of Condorcet, and this system of illumination is known as "Fresnel's system."

For many years the superiority of French glass left England entirely dependent on that country till Mr. James Chance, of Birmingham, took the matter in hand; and the Trinity House exhibition in Paris proves the success that has crowned the labours of this talented and indefatigable gentleman, both in respect of glass, workmanship, and optical science.

The following is a list of the various lenses, &c., exhibited by England:—

1. A first-order fixed light for 360 deg. of the horizon, consisting of eight panels of lower prisms, eight prisms in each panel; eight inclined panels of lenses, each panel having a central belt and eight rings above and below it;

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eight panels of upper prisms, 18 prisms in each panel. The 24 panels are connected together by a gun-metal armature, and mounted on a cast-iron lens curb, which is supported on ornamental cantilevers secured to the lantern block ring. By Chance Brothers, of Birmingham.

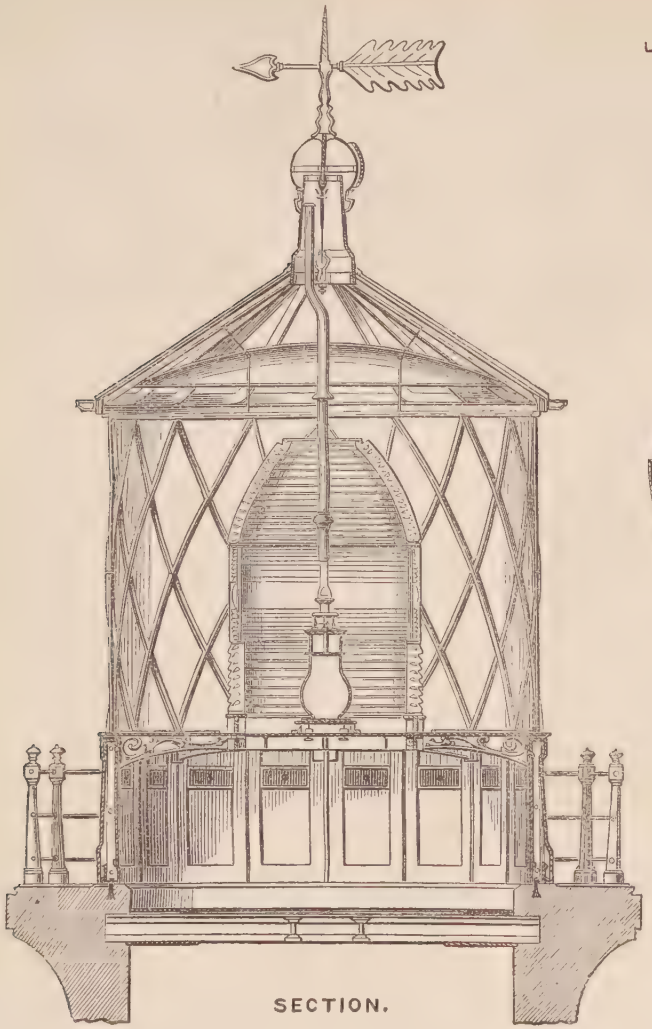
2. An eight-sided revolving light of the first order, with gun-metal armature, mounted with its rotatory carriage on a square pedestal, with glazed doors containing the clock-work. An improved pressure-lamp is placed inside this apparatus.

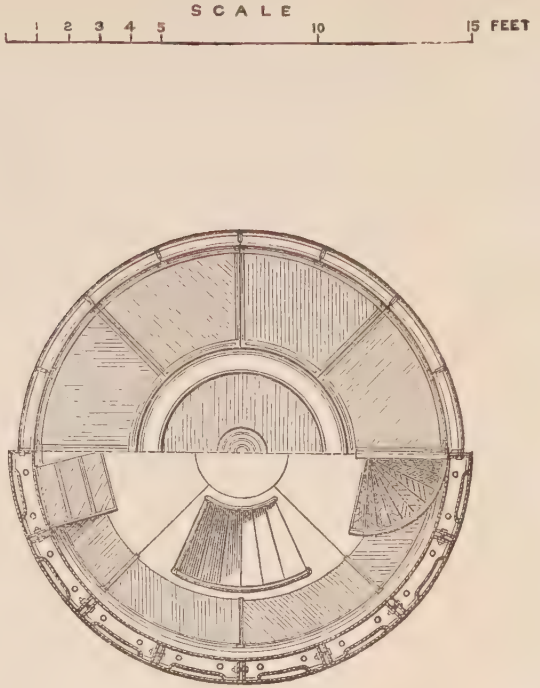
3. (In the Park.) A third-order fixed light, to illuminate 288 deg. of the horizon, and on the land side an arc of 72 deg. having Mr. Thomas Stephenson's dioptric mirror with the improvements of Mr. James Chance. This apparatus is arranged for the electric light, and has ten upper prisms, and inclined lenticular panels, consisting of a central belt, with six rings above and below. The dioptric mirror is made in halves, so as to allow of its being opened to afford access to the electric lamp and for cleaning. The standards of the upper and lower frames are made to alternate with each other. The whole of the apparatus is mounted on an ornamental cast-iron circular pedestal. This light is erected inside a temporary lantern with its framing coinciding with that of the apparatus. The joints of the lenticular zones are inclined in the directions of the corresponding refracted rays from the focus.

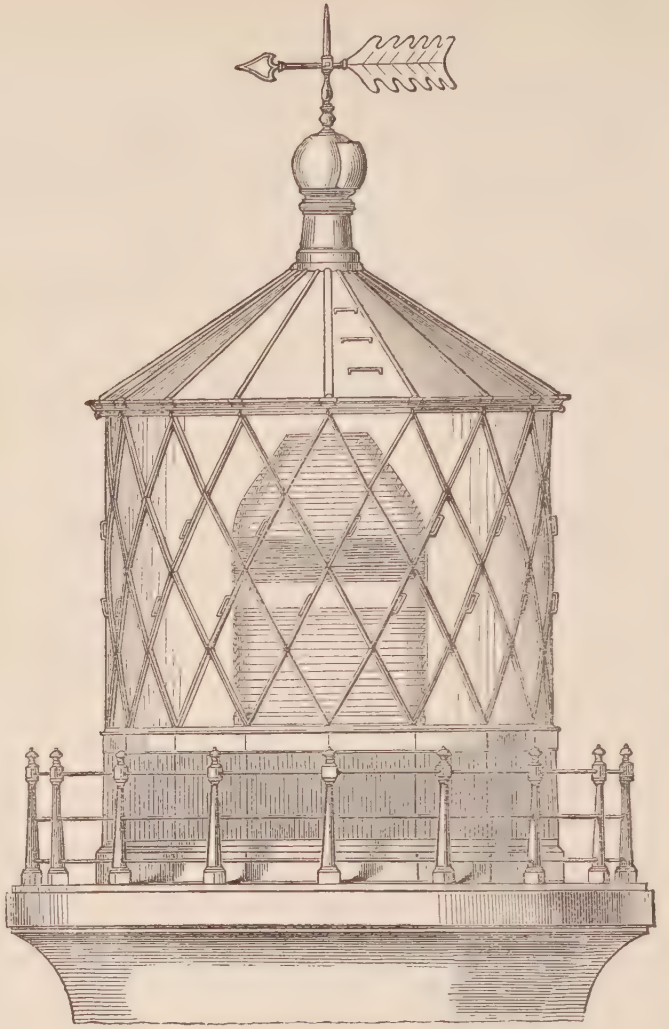
4. (In the Building.) A small third-order fixed light, designed by Mr. Thomas Stephenson, to condense its light into 45 deg. This apparatus consists of 180 deg. fixed light, the 45 deg. in the centre giving direct light, and the 67½ deg. on each side being condensed over the central 45 deg. by means of a dioptric reflector, the same as that already referred to, whilst a fourth-order semi-holophote condenses the rays passing above the mirror, and throws them on a set of rectangular reflecting prisms, so curved as to transmit the light falling on them over the arc of 45 deg. required to be illuminated. In use in the Tay.

5. A first-order dioptric mirror for 180 deg. The light, radiating from any point in the vertical axis, is returned upon a corresponding point in the same horizontal plane by two internal reflections. The idea was originated by Mr. Thomas Stephenson in 1850, but was first carried into effect by Mr. James Chance in 1862. Intended for Ushinish.

6. A fixed floating light, composed of eight small beehives, of 180 deg. each, of the eighth order. Each apparatus is fitted with a reflector and lamp, the whole being mounted in a small lantern. By Messrs. Milne, of Edinburgh.



J. DOUGLAS'S FIRST ORDER LANTERN.

7. A sixth-order holophote, with dioptric mirror of flint glass, having the successive rings abutting together. This mirror is constructed on the principle of Mr. Thomas Stephenson (already referred to), and was the first one ever constructed, the work having been successfully carried out by Mr. James Chance.

8. A sixth-order holophote, with metallic reflector.

9. A 21-inch parabolic reflector, with a small holophote in front, $10\frac{3}{4}$ inches diameter of periphery. A portion of the above reflector at its back is replaced by a spherical metallic mirror, of the same opening as the diameter of the holophote; the whole is fitted on a stand with a lamp.

10. A sixth-order fixed light, with a segment of holophote attached, throwing its light on a set of vertical prisms, intensifying a particular arc.

A first-class mechanical pump lamp, by Milne and Co., of Edinburgh.

The lantern exhibited by the Trinity House is a first-order one, designed by their engineer, Mr. J. Douglas. It is intended for the Wolf Rock Lighthouse. The chief difference between this lantern and all former ones is that the glass of it, being cylindrically curved, affords the greatest degree of optical accuracy, and the helical steel framing offers the least possible obstruction to the light, it being practically nil.

Wolf Rock.

The Wolf Rock lies midway between the Scilly Islands and the Lizard, about $22\frac{1}{2}$ miles from either, and almost in the fair way of ships bound from the Channel either to the west coast of England, to Ireland, or Scotland. It is submerged at high tide, and, owing to there being deep water all round it, the lead gives no warning of its proximity. From time immemorial, therefore, it has been a terror to navigators bound to any of the above-named destinations, and still more so to inward-bound ships, which in the dark and stormy winter months have not been able to correct their reckoning by observation of sun or stars. In the earlier days of engineering science the impracticability of placing a lighthouse on it, owing to its exposed position, its great distance from land, and, above all, to the heavy sea which at all times breaks over it, appeared to be insurmountable. In 1840, however, the lighthouse authorities determined to try and place a beacon on it, which, after various failures, was accomplished at an outlay of 10,000*l.*, and after seven years of danger and disappointment to the builders. This beacon, however, could only be seen by day, and the terrors of the Wolf during dark and stormy nights remained undiminished. When the eminent engineers, Messrs. Walker and Burgess, had succeeded in 1858 in crowning the Bishop Rocks, which

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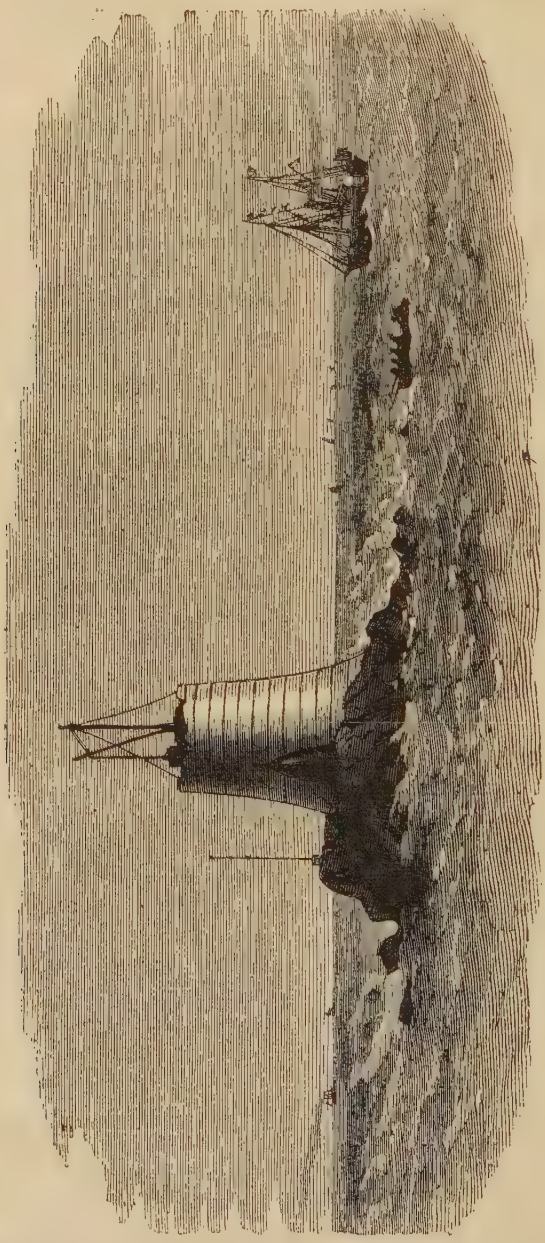
lie to the S.W. of the Scilly Islands, and on which Sir Cloudesley Shovel and his fleet suffered shipwreck in 1707,



WOLF ROCK LIGHTHOUSE.

with a lighthouse, the greatest triumph of engineering skill extant, the Trinity House authorities applied for the Govern-

ment sanction to erect a lighthouse on the "Wolf," which was unhesitatingly granted, and the first stone of the building shown in the illustration was laid by their engineer, Mr. W. Douglas, on Aug. 6, 1864; since which, through his indefatigable energy, and after the frequent destruction in a few minutes of the work of days, the lighthouse has in the course of three summers attained the height shown in the sketch taken on Aug. 21, 1867, a progress so unexpected that the authorities hope to exhibit the light from it in the course of a couple more years. The light, which will be a powerful first-order dioptric one, showing entirely round the horizon at a height of 110 ft. above high water, will not merely warn ships off the rock, but will act as a point of departure and a landfall for both outward and inward bound ships; for, standing as it does, out in the midst of the ocean, navigators will not hesitate approaching close, though at present they give so wide a berth to the Wolf Rock.



Before entering on this subject it may not be irrelevant here to call attention to an axiom in the theory of light produced by chemical action—viz., that its production depends on two conditions: first, that there must be solid particles in a condition capable of taking up the velocity; and, secondly, chemical action to impart the velocity to them. For instance, in the lime light we have the combination of hydrogen and oxygen which produces of itself but very little useful light, as it is purple; but when the combined flames are made to play on a piece of lime, the heat produced by the combining gases sublimes the lime, and then the particles or atoms floating in the flame produce an intense white light.

Theory of light.

In the oil lamp the hydrogen of the oil unites first with the oxygen of the air, and during this combination the particles of liberated carbon are floating in the combining gases as the particles of the lime were in the former instance; but, as the combination in this case is not nearly so violent, or rather as the velocity of the combining hydrogen and oxygen is not so great, the light produced is less intense. As, therefore, electricity exceeds all other means of giving velocity to such particles, so must the light it gives be of greater intensity than all other known lights.

As this light is now in use on both sides of the Channel, it may be well, before describing those in operation at the Great Paris Exhibition, to remind our readers of its origin. In 1831 that great and modest man Faraday announced to the world his grand discovery—viz., that whenever the magnetic force in a soft piece of iron or steel is being increased

Electric light.

Capt. Close on Light-houses and Coast Illuminators.

or diminished a current of electricity will be induced in a coil of insulated wire wound round such piece of soft iron or steel; to this discovery was soon added the knowledge that the force of the electric current thus produced is proportional to the magnitude of the increase or diminution divided by the time in which the change takes place; and, further, that the current thus produced is modified by the length and size of the wires employed being changed from a current that will melt a large iron wire on passing through it, but which at the same time will pass through the human frame unfelt, to a current that will not warm a small wire, but which will or can cause instant death to any living creature. The object, therefore, of the arrangement of all the parts is, first, to arrive at a maximum of electricity from a given weight of magnets, and, secondly, to modify the current in the coils, so that the shock shall be trifling, but the intensity great enough to produce a permanent light.

Faraday and Holmes.

The application of the immortal Faraday's discovery to the purposes of coast illumination is solely due to the scientific attainments and great mechanical skill of Professor Holmes, whose indefatigable perseverance for more than a quarter of a century resulted in the magnificent light which was first shown from the South Foreland in August 1858, was permanently placed at Dungeness, and has since been brought into use at Cape La Héve, to light the entrance to the River Seine, and will, moreover, shortly be shown from a lighthouse in the course of erection on the coast of Yorkshire. The great Paris Exhibition has afforded world-wide opportunities of witnessing its splendid effect.

In the electric light first experimentally used by the light-house authorities at the South Foreland and finally placed at Dungeness, the arrangement is as follows; viz., there are three concentric rings of magnets, and between the poles of those forming the first and second rings, and also those forming the second and third rings, the rims of two brass wheels revolve. The rims of these wheels are hollow, and contain the "helices" or "bobbins," but the soft iron cores round which the wire of the bobbins is wound are screwed into the sides of the hollow rims, and are turned off flush on the outside. The wires of all the helices or bobbins are connected together in series in the rim of each wheel, and the terminal wires are carried down behind the panel to four screws, two of which screws receive the wires for each wheel. These wires are carried through the hollow axle of the wheel to the outside of the bearing, and are there joined to their respective commutators. The commutators are contrivances by which the alternating currents of electricity induced in

the helices are directed, and thus the entire current passes from the machine in one direction, instead of alternating, and forms a constant current.

Magneto-electric machines.

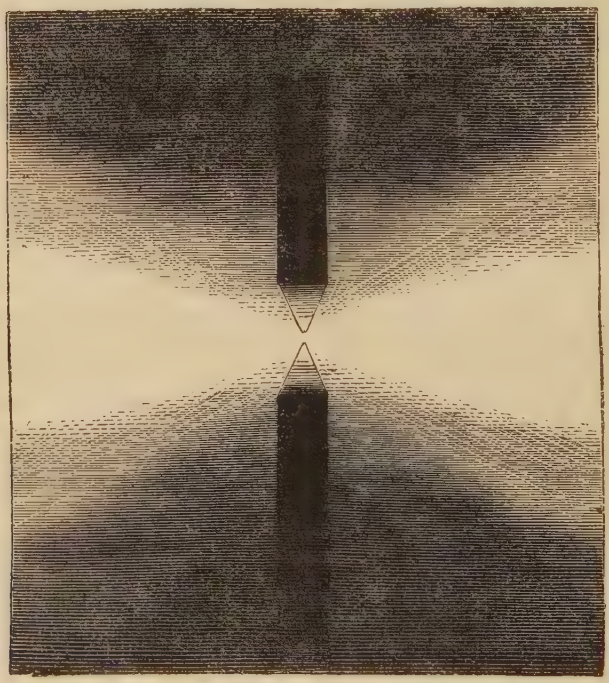
The magneto-electric machine in the English portion of the Exhibition in Paris differs from that at Dungeness simply in this, that each machine consists of six brass wheels, every wheel having 16 helices of insulated copper wire. Inside each helix is placed a hollow core of soft iron; the wheels are all firmly fixed on a shaft, which is driven by an Allen steam engine. The horse-shoe magnets are placed in rings of eight in each ring, with their 16 poles in the same plane pointing inwards towards the axle, and so adjusted that the distance from centre to centre of the poles is exactly equal to the distance from centre to centre of the cores of the helices. The magnets are so arranged that, whether counting the poles around one ring, or counting longitudinally through the seven rings, the poles are alternately north and south poles. In each machine there are 96 helices and 56 magnets. The intensity of current depends on the length of the wire throughout the connected series of helices; the quantity of electricity depends on the quantity of magnetism induced in the soft iron cores, and on the velocity with which this quantity is taken up at each reversal of the poles. Experience of this engine shows us that 6,400 changes of polarity per minute give the best result for light. No wood is employed in the English machine. The electric current is conducted through the wires to the lantern, where it passes alternately through the carbons, and at the points of these, when nearly in contact, the effect described at the opening of this subject occurs (see Engraving), and the most brilliant light known is the result.

The English and French electro-machines now in operation at the Paris Exhibition, though differing in construction, are the same in principle; so is the motive power, only that the French use the driving strap, whereas our electric engine is worked by the direct action of the steam engine; experience alone can prove which will turn out the most efficient. The English light is shown in a fixed lens, because the position it is intended to occupy on the east coast of England is that of a fixed light; and however glad the lighthouse authorities would have been to test the great increase of power a revolving lens would have imparted to it, they had no such lens ready to experiment with. The result obtained in the fixed lens has proved a great success. Viewed from the hills surrounding Paris, the long-wished for opportunity of testing the effect of the electro-magnetic light against the ordinary dioptric system is afforded by the beautiful revolving first-order

CAPT. CLOSE ON LIGHT-HOUSES AND COAST ILLUMINATORS.

dioptric light intended for the Roches Douvres and shown from the fine iron lighthouse built for those rocks and placed in the French section of the park. This induced the English authorities to put up a rough scaffolding, on which, at a height of 145 ft., and nearly on a level with the French dioptric revolver, their electric light is exhibited. Had the French electric one

English electric light in park.



THE ELECTRIC LIGHT.

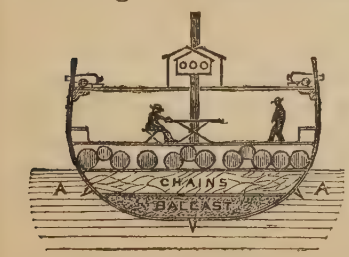
been at a similar elevation, there can be no doubt that the powerful concentration into one beam of those rays which in a fixed light are scattered round the horizon would have been made amply manifest; nothing, however, could be more beautiful or dazzling than the effect of the French electric light already described, shown as it is at an elevation of only a few feet from the ground, through alternating coloured lenses. I may take this opportunity, in the name of my colleagues and myself, of offering our tribute of thanks to M. Léonce Reynaud, Inspecteur Général des Ponts et Chaussées, for his kind courtesy in affording information on every subject connected with his department of this beautiful exhibition. Whatever rivalry there is here is an international and honourable rivalry of science and art, and one that can only result in the good of our fellow creatures.

French electric lights in park.

The French electric light, or rather two lights, exhibited from the windows of a small building in the park, differs from the Dungeness one in that whilst the latter consists of three rings of magnets, with their poles outwards, radiating from the centre, each ring consisting of 20 magnets or 40 poles, the French machine has seven rings of eight magnets each, or 16 poles (*i.e.*, 112 in all), the poles of the magnets turning inwards; between these turn six wheels, each containing in its periphery 16 helices. The maximum intensity of light is attained by a speed of from 350 to 400 rotations per minute, whereby the electric current is inverted about 100 times in a second. Another difference between the French machine and the Dungeness one is due to an improvement of M. van Maldern, and consists in doing away altogether with the commutators. The magnets in the French machine are of a power of about 60 kilog. each. There are two engines and two electric lamps; the second engine is used in hazy weather to augment the intensity of the light, or in case of accident to the other engine. This light, like our own, is furnished with magneto-electric clockwork, which regulates the movements of the carbons; these, however, require constant watching. Although the electric current passes alternately through each of the carbon pencils, it is found that the lower one burns away more rapidly than the upper one in a ratio of about 108 to 100, necessitating a very delicate and intricate arrangement of the clockwork and frequent manipulation.

Light-ships.

The objects chiefly aimed at in the construction of these vessels are as follow; namely, that of ensuring as far as possible their permanence of position, especially in stormy weather. The form, therefore, that offers the least resistance to the sea, and thereby the least motion to the vessel, is the one most likely to ensure permanence of position. The best proof that this has been attained is the fact that, of the 50 light-ships that guard the coast of the United Kingdom, there is no record of accident accruing to any ship owing to the absence of a light-ship from her station. The form of hull that ensures easiest riding also affords the best exhibition of the light she carries, and, moreover, tends to reduce the cost of repair, inasmuch as she will strain less than one where the motion is quicker. To ease the rolling as much as possible, rolling-chocks are bolted along the bilge of these vessels, as shown in the transverse section A, A. By far the larger portion of these light-ships belong to the Trinity Board. These are all painted red, as in case of acci-



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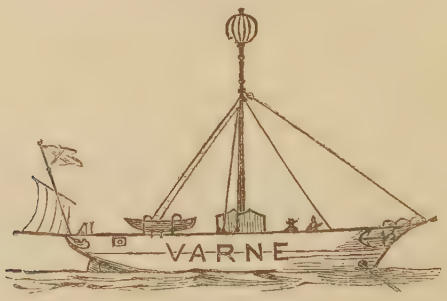
dent any one may at a moment's notice have to be substituted for another.

As distinction of character is only second in importance to permanence of position, these vessels are furnished with from one to three masts, each surmounted by a globe 18 ft. in circumference. So, should a one-masted light-ship have to be suddenly relieved by a three-masted one, the fore and mizen masts are instantly hoisted out; the name, which is that of the shoal she guards, and is painted along two thirds of her side, is changed, and by the time a tug is ready to take her to the required station she is in a condition to proceed there. The accompanying Illustration will explain the manner of mooring these vessels so as to ensure ease in riding, the cable passing from the mooring-bitts out at a hawsehole near the water-line.




The "Varne."

The lantern has a strong gun-metal frame, glazed with the best plate glass, the argand lamps in which vary according to the character of the light exhibited. The reflectors are silvered, and, with their oil cisterns, are hung upon gimbles, so as to keep the focus of the flame (no matter what the motion of the vessel is) always in the plane of the horizon. The lantern is kept in a deck-house during the day, where the keepers trim the lamps and polish the reflectors, and at sunset it is hoisted by a powerful winch into its place on the mast.

A warning-gong, suspended in the fore part of each vessel, is beat during fogs, and each vessel is furnished with two guns to warn ships running into danger, or to be fired as signals of distress at night, in case of a ship getting on the shoal, when rockets are fired in the direction of the stranded ship to point her position out to whatever succour may be sent from the shore. These vessels are furnished with a strong jib and mizen, either for ease in canting to the tide or in case of breaking adrift. The average cost of a light-ship

fully equipped (exclusive of stores) is 3,600*l.* and the average cost of maintenance about 1,100*l.* per annum



France has three light-ships. They are in all respects nearly identical with ours. Two of them are in the roadstead of Dunkerque, both showing red lights, one fixed, the other revolving every 30 seconds. These were first lighted on Nov. 15th, 1863. The third light-ship guards a dangerous reef in the Bay of Biscay, in as exposed a position as any of our English vessels. Our method of mooring with heavy iron mushrooms is also in use in France, and their internal arrangements for the accommodation of the crew or the reception of shipwrecked men, as also their oil and other store rooms, are identical with our own.

French lightships.

A model of the light-ship at the Goodwin Sands is exhibited, the planking being omitted on one side so as to show the internal fittings and arrangements. She is three-masted, and shows her lanterns hoisted up for night service. The organization of the light-ship service round the coast of England is shown in another portion of this report.

The following models are shown in this department:—A model of "apparent light"—a beam of light projected on a beacon from a lighthouse on the shore is reflected and shows the position of the beacon; model of first-class iron beacon; model of electric induction spark for illuminating beacons at sea; model of a first-class holophote revolving, the light which passes above and below the prisms collected into eight horizontal beams; model of a dioptric holophote fixed; model of a dioptric mirror, rendered holophotal; a 12-in. light ship reflector; and a catadioptric holophote, with spherical mirror.

Models of lenses, lighthouses, &c.

The following are models of the lighthouses exhibited:—Bell Rock Lighthouse, Kerryvore, Hamois, Skerries (Holyhead), Bishop's Rock, Reculvers, Menai, South Bishop's Rock, Eddystone, Needles, Wolf Rock (in course of erection), Cocket (and dwellings), Smalls (old pile lighthouse), Maplin (iron ditto), and Gunfleet (iron ditto).

The geometric signals are also shown in this department. Each light-ship and every rock lighthouse is furnished with a set. These signals can be used when the distance is too great to make out the colours of flags or where there is not wind enough to blow them out. The following diagram

Geometric signals.

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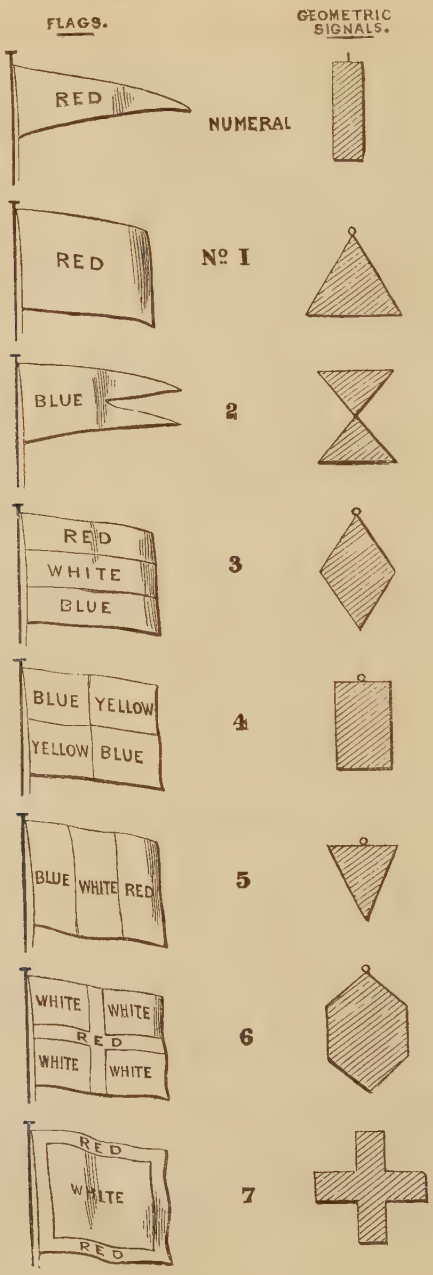
shows the form of these signals and the flags they represent; they have been five years in use, and are found efficient:—



Photometer.

Photometer by Captain Nisbet (Trinity House). This instrument has two electro-plated metal tubes, 10 in. by 2½ in. The tubes are placed over each other, with a sight tube between for observing. The lower tube is glazed at the end and inside it is a small telescope working like a piston in a stuffing-box, with rack and pinion; a communication between the tubes allows a neutral tinted fluid with which the upper one is charged to flow into the vacuum till its density is sufficient to eclipse the light of a candle; the fluid can be made to represent any condition of the atmosphere from "clear" to "dense fog." A graduated scale on the side of the instrument shows the different degrees of density through which lights can be seen, and by this the comparative value of distant lights are calculated.

Fog signal and signal lamps.

In addition to the warning from lights and beacons, other sources of safety to the mariner were exhibited by the means of Sound, which are of great value when the state of the weather renders lights or beacons invisible. These consisted of an air trumpet of great power, the invention of the late Mr. Duboll, an American; the motive power being a caloric engine; also an air trumpet worked by steam, and attached to the electric light machinery, the invention of Professor Holmes. Either of these air trumpets in favourable condition of the atmosphere and down wind may be heard for a distance of seven to 10 miles, the trumpet rotating at each blast to a different point of a compass. There is also a powerful 9-cwt. bell, worked with clockwork, by Messrs. Dent and Co., which strikes three strokes every ten seconds; and as any number of blows, at any interval, may be arranged in the same way for purposes of distinction, sailors are by this means enabled to identify their position in any state of weather.

Patent fog-signal, by Lieutenant G. Key, R.N., of 179, St. George's Street, London, has numerous advantages over the old horn, the principles of which are that it is blown by a pair of bellows, and may be used by a boy; and that the reed of the horn is protected, and therefore lasts longer; in addition to which it gives a louder and more prolonged blast.

A fog-horn, exhibited by France, in the park, consists of an air-pump worked by a steam-engine. The horn, 2 metres in length, terminates by a right-angled curb, furnished with a metallic vibrating whistle. A horn of this description has been some time successfully used at Dungeness.

Nunn's side lamps, now in general use, appear only second to those lately adopted by the Trinity House with dioptric lenses made by Wilkins and Sons, of Long Acre.

Capt. Close on Light-houses and Coast Illuminators.

The accompanying diagrams explain the character of these lamps. Nos. 1, 2, and 3 are bow, masthead, and anchor lamps; the other (Fig. 4.) is Nunn's patent convertible signal-lamp, combining port, starboard, masthead, and anchor lights in one.

Nunn and Browne's course-indicating binnacle lamp (Fig. 5) and index is placed in the top of the binnacle, its oil-chamber supported on a double swivel, or gimbling, which always keeps it in a perpendicular position; therefore no overflow of oil can occur, let the ship roll or pitch as she may. The glass is in the bottom, and the reflector below the flame; consequently, neither can be sullied by smoke. The oil-chamber is cylindrical and elongated obliquely downwards, the centre being hollow and its circumference polished for reflecting, whereby the lighted wick, which is fixed within it at its upper level, casts its light effulgently on the compass-card below. The bearing of any object can be taken in the night-time with facility, as the shade of the binnacle can be removed at any time without interfering with the light on the compass-card in consequence of it not being encumbered with the lamp.

The following diagrams fully illustrate the formation and use of these lamps:—

Fig. 1. Nunn's Side Lights.

F. N. Gisborne's pneumatic signals for ships enable the captain to communicate from the bridge of a steamer to the helmsman and engineer, to receive their replies, and to not

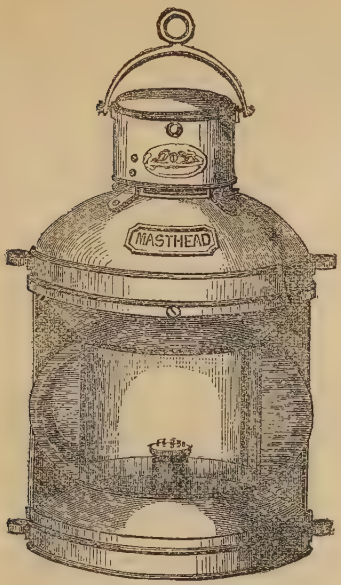



Fig. 2. Nunn's Masthead Light.

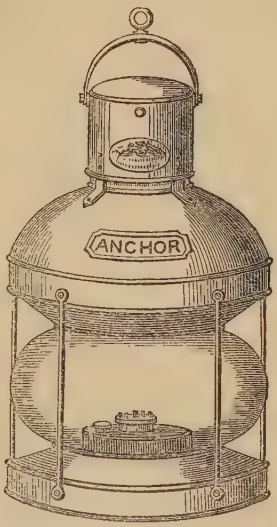



Fig. 3. Nunn's Anchor Light.

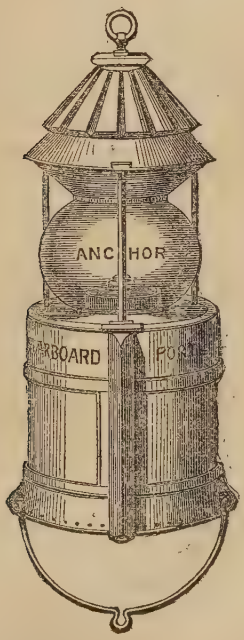



Fig. 4. Nunn's Convertible Lamp.

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the actual movements of both rudder and engine; thus, in case of danger from collision at sea, during intricate navigation, entering harbour, or in foggy and stormy weather, the vessel is under perfect and immediate control, and can be

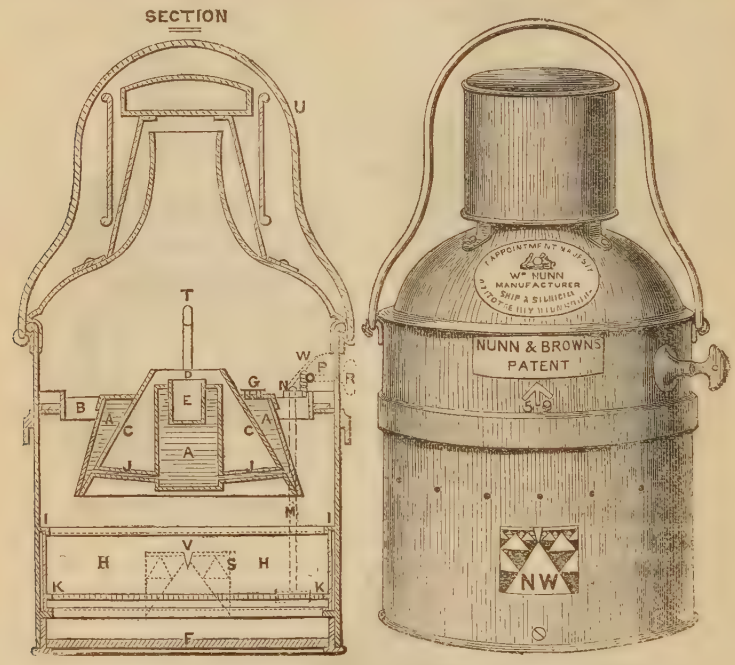



Fig. 5. Course-indicating Binnacle Lamp.

handled with confidence and safety. A small metal pipe, placed within a half-inch iron gaspipe, and carried under the deck beams, connects the several instruments, the motive power being derived from the column of air within the inner pipe, while the outer pipe serves to convey a current of air for sounding the "attention" and "reply" whistles. By turning the handle of the captain's bridge-communicator, the pointers upon his and the helmsman's dials move instantly and in perfect unison, the same column of air giving motion to both. It is thus evident that change of temperature, or even a leak in the inner pipe (a very unlikely contingency), would not in the least affect the correctness of the signals transmitted; while any lost air would return through the place of escape the moment the pointers are at rest. So soon as an order is obeyed, the rudder-head tell-tale, which is self-acting, indicates upon the bridge-communicator the position of the helm to port or starboard before the alteration of the helm acts upon the ship's course, allowing ample time and

opportunity to correct any possible error the helmsman may make. For engine-room signals, appropriate orders are painted upon the dial faces, and the tell-tale shows upon the captain's communicator every revolution of the engine "ahead" or "astern." The advantages of this system of signalling are manifold—the motive power costs nothing, being air; the pipes may be carried irrespective of angles; the internal structure is so simple that it can be repaired, if necessary, at sea; duplicate parts are inexpensive; and, should the piping be shot away, a small length of india-rubber tube slipped over the several ends instantly repairs all damage. Lastly, the whole apparatus is ornamental and inexpensive.

F. N. Gisborne's electric signals, now in use by the British Government on board the iron-clad fleet, attain by means of the electric current precisely the same control of the vessel as the pneumatic signals, a full description of which has just been given. They are simple and effective, and, the orders being painted on enamelled glass, are visible by night or day. A bell calls attention to the order, and a reply is transmitted by pressing a small knob or lever placed within easy reach of the helmsman or engineer.

Warning lights (10) of intense brilliancy, instantaneous action, and a power of sending their light 10 miles, are exhibited by Messrs. Colomb and Bolton. A description of the mode of using them is given with each box.

Colomb's system of flashing signals is said to be very effective and intelligible in all weathers. Its simplicity is its great recommendation, a sort of barrel-organ measuring the length of the flashes, and reducing the system to a mere mechanical arrangement. It has been fully described in Major Leahy's Report on Class 37, "Military Telegraphy and Signals."

The night-signal apparatus for sea service by the same inventor consists of a fitted lamp and signal-box, and a gibbet for suspending the lamp, fastened to the ship's side.

In the interior of the lamp there is a semi-cylindrical shade, which falls by its own weight, and completely obscures the light; when raised it completely exposes it, and thus produces flashes of longer or shorter duration. This shade is connected with a lever in the signal-box, which contains a barrel or cylinder, turned by means of the handle. The surface of the barrel is occupied by series of pins and bars, each series representing the numeral flashes. Parallel to the barrel is an iron bar, upon which the keys travel horizontally; and above the bar there is a flat brass plate, termed the director, on which four series of figures are engraved, and

Capt. Close on Light-houses and Coast Illuminators.

slots placed opposite each figure for the reception of the keys. The revolution of the barrel causes the pins on its surface to operate on the keys, which transmit their motion to a lever and to the lamp shade. It is therefore only necessary to place the keys in the slots corresponding to any required series of figures, and then to turn the handle continuously to produce a revolving series of flashes, corresponding to the setting of the instrument, with unfailing accuracy.

Buoys, &c.

It should be observed that there is a uniform system of buoyage adopted by the Corporation of the Trinity House.

White buoys for many years were used by the Elder Brethren as a distinctive character; but as experience has proved that, under certain conditions of light, white is difficult to be seen, buoys of this colour alone have been entirely abandoned.

There has also been found a difficulty in distinguishing the colours black and red at all times. The Corporation have, therefore, now adopted the following system; viz., the side of the channel to be considered starboard or port with reference to the entrance to any port from seaward.

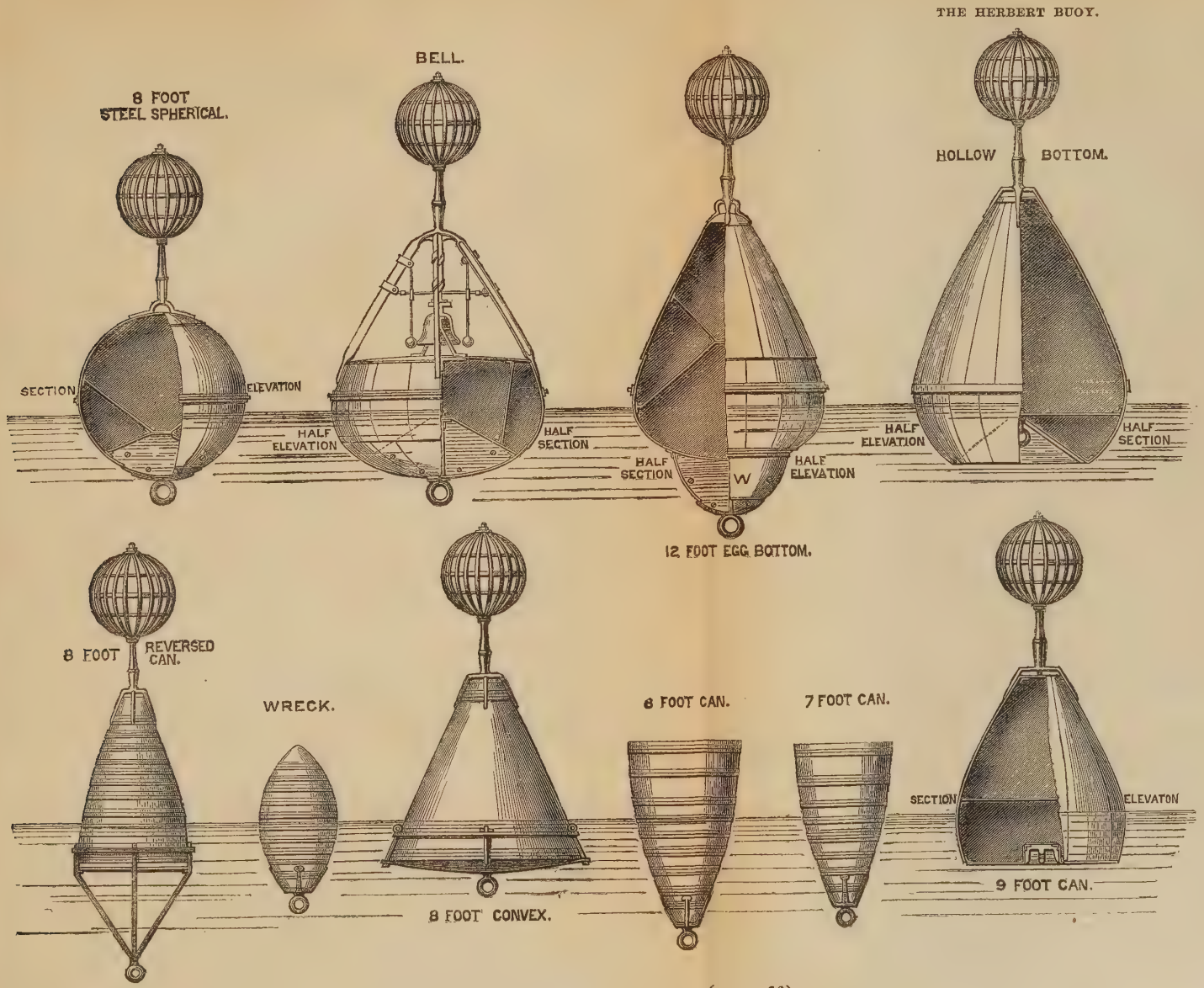
The entrances of channels or turning points shall be marked with spiral buoys, with staff and globe, triangle, &c.

Single-coloured can buoys, either black or red, will mark the starboard side; and buoys of the same colour, either chequered or vertically striped with white, will mark the port side. Further distinction will be given, when required, by the use of spiral buoys, with or without staff and globe or cage; globes being on the starboard hand and cages on the port.

Where a middle ground exists in a channel, each end of it will be marked by a buoy of the colour in use in that channel, but with annular bands of white, and with or without staff and diamond or triangle, as may be desirable, when required the outer buoy being marked by a diamond and the inner by a triangle.

When a middle ground divides a channel into two, and it is necessary that each should be buoyed, the right-hand channel will have red as the predominating colour, and the left-hand black; each side of the middle ground being marked by buoys proper to it as the side of a channel. The end buoys would be coloured in annular bands, as provided in the preceding paragraph, the outer red and white, the inner black and white.

When a middle ground is passed, and two channels thus buoyed merge into one again, the colour of the right-hand channel shall be continued as if no other existed.




BUOYS USED BY THE TRINITY HOUSE (CLASS 66).

Wrecks will still continue to be marked with green nun buoys.

Should two channels in close proximity to each other require to be marked, the same buoys and same colours may be used, only inverting the buoy, *i.e.*, mooring them in one channel from the apex or small end, and in the other from the base.

In the Trinity Board department of class 66, 11 models of different descriptions of buoys are exhibited, either in wood or iron. The total number in use belonging to this board is about 400, and as these are brought into store, for painting and repairs, every six months (for in that period salt water and exposure destroy their distinctive character) it is necessary to have the same number of duplicate buoys to replace those brought in. This buoy-shifting, which takes place twice in the year, is one of the most arduous duties the Trinity steamers, as a rule, have to perform, seeing that these buoys for the most part mark dangerous shoals, and the change is effected at times, and frequently under circumstances of considerable difficulty. Iron has of late years superseded wood in the manufacture of buoys, as being more durable and buoyant. The following diagrams of wooden buoys will explain their difference in form; viz., first, the wreck buoy, always painted green, with "Wreck" in white on the upper portion of it; next, the can buoy—these are black, with the name in large white letters on the flat exposed surface; then the "can" reversed—this was intended not merely as a distinction, but to render the buoy more visible, three iron legs being fixed to a strong hoop round the lower part of the buoy and the moorings attached to a ring where these meet, the buoy exposes a much larger surface above water than before. These buoys are much used, and painted in every variety of way to indicate the different shoals they mark, *i.e.*, checked and ring stripes horizontal and vertical, &c.

The iron buoys are those most deserving notice in the small space afforded for the subject here. These vary in size from 9 feet to 20 feet. The latter, which are termed "monster" buoys, guard dangerous shoals, where the traffic is great, such as the back of the Goodwin Sands, &c.; they are built of wrought-iron plates, riveted on a strong iron frame, the lower portion of which is divided into water-tight compartments. The "egg"-shaped or "water-ballast" buoys are those which retain their upright position best under all circumstances of high sea, wind and tide, &c. Their shape is shown in the diagram, the W indicating the water-ballast portion, which, though forming a part of the framing, is an

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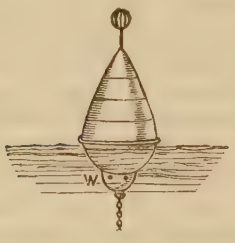
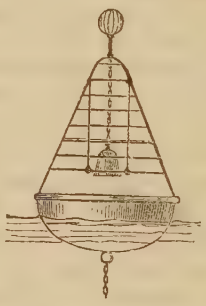
excrescence on the base of the buoy, the plating of which separates the water-ballast cup from the other portion. This iron cup is pierced with holes (H, H), to admit the water, which, when the buoy is hoisted up for shifting, is allowed to drain out and so lighten it.

Herbert's buoy is much the same in appearance afloat, but is the inverse of the "egg" buoy, the base of it being an inverted hollow cone (see engraving below). The idea is that the sea striking the inside of the cone, opposite to the outside struck by the same wave, would counteract the effect of the outer blow and keep the buoy in its position, and that the mooring-ring, being nearer the centre of gravity, would tend to lessen the motion of the buoy. Neither of these positions has resulted in practice; and, though the buoy is a conspicuous one, the hold offered to the wave by the hollow cone, in a monster buoy, brings a greater strain on the moorings than in the egg-shaped one.

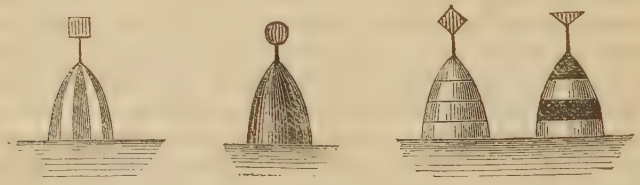


EGG-SHAPED BUOY.



BELL BUOY.

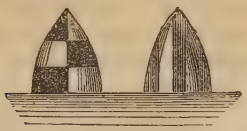
The bell buoy is the only one now to be noticed. Either of the above buoys cut down to where the ring-fender is shown, and decked over so as to be water-tight, and a light iron framing substituted for its original heavy one (thus preserving the form of buoy), constitutes the frame for a bell-buoy. A bell being fixed in the centre of this frame



GOODWIN MONSTER BUOYS.

with four clappers hung from the apex, and having a guide-rod to ensure their striking the bell, every movement it makes will cause one or other of the clappers to strike the

bell, and thus a continuous ringing is maintained, while the sea washes over the deck of the buoy beneath the bell. The bell is a fixture, the clappers hanging loose.



INVERTED CAN BUOYS.

GREEN WRECK BUOY.

The distinctive character given to the monster buoys is not merely in their colour, but also in the form of the beacons that surmount them, which are as follows:—(1) globe; (2) diamond; (3) cage; (4) triangle; (5) triangle inverted.

1. 2. 3. 4. 5.

These are so constructed as to show their form from every point of the compass.

Hydraulic lift graving dock.

Model of "Hydraulic Lift Graving Dock" (11), by Edwin Clark, 24 Great George Street, Westminster, London. This lift is a direct mechanical appliance for raising vessels completely out of the water by means of hydraulic presses. It consists of two rows of cast-iron columns, 60 ft. apart; in each row there are 16 columns, 20 ft. apart, each column inclosing a hydraulic press, of 10 in. diameter and 25 ft. length of stroke. Between each pair of columns, extending entirely across the dock, are suspended girders, lying at the bottom in 27 ft. water when the presses are lowered, but rising above the surface when the presses are raised, forming a large wrought-iron platform or gridiron, which may be raised or lowered at pleasure, with a vessel upon it. The lifting power of each press amounts to 200 tons, or 6,400 tons for the whole lift. The girders are designed for carrying the vessel as a load at the centre, although the load is distributed by a pontoon placed beneath the ship and the wide base used for the blocks. The raising of a vessel occupies about 25 minutes, and is effected as follows:—An open pontoon proportioned to the size of the vessel, with keel blocks and sliding bilge blocks adapted to her shape, is placed on the girders and sunk with them to the bottom. The vessel is then brought between the columns and moored securely over the centre of the pontoon. By lifting the girders the

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keel blocks are first brought to bear under the keel of the vessel; the side blocks are then hauled in, and the gridiron and pontoon, with the vessel upon it, is raised clear of the water. The pontoon, by means of valves, empties itself of water; the valves are then closed, the girders again lowered to the bottom, leaving the pontoon with the vessel upon it afloat.

Thus in about 30 minutes a vessel drawing 18 ft. of water is left afloat on a shallow pontoon drawing only 14 ft. 6 in., and may be taken into the shallow dock prepared for its reception.

The principal features of this system may be summed up as follows:—

1. Its economy, as well in its first construction as in its subsequent maintenance.

2. Its adaptability to almost any situation, especially in harbour or tideless seas.

3. The capability of almost indefinite extension, by the construction of additional pontoons, or, as regards the lift, by the addition of extra columns.

4. The simple and durable character of all its parts, and their perfect accessibility.

5. The short time required for its construction and erection.

6. The rapidity of its manipulation and the small staff required.

7. The convenient access afforded to all parts of the ship, and especially in painting iron ships, and their free exposure to light and air.

8. The freedom from strain with which vessels, even in cargo, may be docked.

9. The means afforded of rendering any area of shallow water available as a dock for the largest vessels.

Life-boats.

Collapsing life-boats, invented by the Rev. L. Berthon, M.A., &c. These boats are constructed of a framework of wood arranged in a longitudinal direction, consisting of a number of flat segmental timbers hinged together at the tops of the stem and stern posts. These timbers, when opened out, extend two skins of an extremely strong, flexible material, one of which is attached to their outer edges and the other to the inner, thus not only completing the form of the boat but dividing the whole body into as many separate air spaces as there are intervals between the timbers. The edges of the timbers are furnished with bands of iron outside the skins to defend them at these salient points. The expansion of the boat by its own weight is kept up by the bottom

boards, thwarts, and certain gunwale supports, all of which are jointed. The advantages of these boats are the following:—

1. Being collapsible, they stow in less than one-fifth of their breadth.

2. Very large boats are capable of being stowed "outboard" against the bulwarks or nettings, ready to expand and lower at any moment.

3. They may be quite supplemental to the ordinary boats of a ship, not interfering with such arrangements, and can be lowered from the same davits.

4. They are insubmergible, and have proved themselves excellent sea boats in all weathers. The largest yet made would carry nearly 300 persons.

Wood and Rogers's patent boat lowering, suspending, and detaching apparatus is shown in the Trinity House department of class 66. The boat is suspended from four points at the sides and not, as usually, from two central points; this method prevents the possibility of its canting while hanging to the davits or during the time of lowering.

Boat-lowering apparatus.

Clifford's Boat-lowering Apparatus.—This plan of boat lowering is now so thoroughly known and appreciated that upwards of 2,000 have been fitted on Mr. Clifford's principle. The boat is lowered by one of the crew in the boat itself, who, from the perfect ease and safety with which the lowering gear detaches itself, can at any convenient instant drop the boat into the water perfectly free of all tackle and while the ship's way is unchecked. Many lives have been rescued by the rapidity with which succour has been thus despatched to them.

Steering apparatus.

Money Wigram and Sons' arrangement of steering, planned with a view to remove the steering compasses from the stern of a ship at which point the magnetic currents acts strongest on the compasses. The tiller is placed athwartships, and fitted with a travelling collar, having on its lower side a nut working in fore and aft guides on a horizontal fixed screw, the shaft of the screw being continued under the deck beams to below the steering wheel. An endless chain working on two pitched wheels, one on the wheel and one on the shaft, communicates motion to the screw. This chain may be carried either direct down from the wheel and over directing pullies, or, if it is required to gain speed or power, motion may be communicated by working the chain on increasing or diminishing geared wheels.

To obviate the wear caused to screw steering gear by the continued shaking of the rudder, the head of the main piece of the rudder is in two lengths, each length having one part

Capt. Close on Light-houses and Coast Illuminators.

Miscellaneous exhibits.

of a clutch-box forged on or keyed to it. Each part of the clutch-box has four projecting segments, so arranged that when the clutch-box is placed in contact these segments come at the degrees of the circle, the space between the segments being filled in with blocks of india-rubber. The clutch-box is held together by bolts and nuts, which, though fast in the lower portion, do not fit tight in the upper, and admit of sufficient play for the india-rubber blocks to receive the blow caused by the sea, and thus prevent the constant wear and injury to the screw and nut.

Patent rudder.

Lumley's patent rudder is in shape and form the same as the old rudder, but is divided vertically into two pieces, the "body" and the "tail," which are hinged, jointed, or articulated together by pintles and braces; the result is, that in putting the helm over either way a self-acting increased movement is given to the "tail," giving increased effect to the power the ordinary rudder exerts on the ship. It is said collisions have been avoided by the increased handiness thus given to the vessel.

Cooking apparatus.

Benham and Sons, of Wigmore Street, London, exhibit half a dozen models of various ships' cooking apparatus, which they have fitted in passenger-vessels for the Peninsular and Oriental and Royal Mail Steam Packet Companies, and in the new Indian troop-ships, and other ships of the Royal Navy. There are several varieties of form and arrangement; but the leading features in all are the same, and in all the same advantages appear to have been secured, which are of special importance on board ship; viz., compact bulk, external coolness, simplicity of management, and economy of fuel.

The most novel arrangement is seen in their circular apparatus, of a pattern which is in use in the new West India Mail steamers, and which consists of two roasting-ovens, two pastry-ovens, two hot closets, a broiling-gridiron, a large hotplate, a steam and hot-water boiler, four steam-kettles, two bainmain pans, a rack-shelf for saucepans, &c., two furnaces, &c., all within a diameter of 7 ft., yet capable of cooking for 300 or more saloon passengers, and baking all their bread and pastry. There are, of course, guard rails to steady the stewpans, and there is also a guttered edge to the hotplate, to prevent overflows from a sudden lurch of the ship. The oven doors are curved, and slide in grooves; there are catches to secure them in their places; there is a water-gauge to show the level in the boiler, and all necessary arrangements of soot-doors and dampers for the cleansing of the flues and the complete control of the draught. The fuel

consumption is said to be very moderate, and the radiation of heat surprisingly small.

The next apparatus in importance and bulk is the troop fire-hearth for the Navy, pattern E. This is of oblong form, and has its furnaces at the front and back, the sides being protected by wood casings, so that all radiation is effectually prevented. It consists of three very large iron boilers for meat, soup, tea, cocoa, &c., capable of cooking for 1,400 men, and with large draw-off cocks for filling the soup-pails; six long iron ovens, shaped like gas retorts, and two large side ovens; the eight being capable of baking 900 lb. of bread, or by opening a valve, of roasting the meat rations for 800 men; also a large hotplate for boiling, stewing, frying, &c., with two large ovens under it for baking or roasting; these latter being appropriated to the use of the non-commissioned officers, the married men, and the invalids. The whole apparatus is put together in three sections, so that either of them may be disused for cleaning or repairs, without interfering with the full action of the others. The management is perfectly simple, and the fuel consumption very small for the work performed. The fire-hearth represented by the model is the size recently fitted in H.M.S. Himalaya and the five new troop-ships for the Indian service; but smaller ones have been in use for some time in H.M.S. Asia and Hector; and one previously in the Emerald, now out of commission, has been refitted in the Phœbe.

Of the remaining models two represent the officers' apparatus and the crew's apparatus, as fitted in the same ships; and a third the saloon apparatus fitted in several ships of the Peninsular and Oriental Company. All alike have ovens for baking and roasting, efficient boilers and roomy hotplates, and the latter has, in addition, steam-kettles for vegetables, fish, &c. All are very compact and handy, and in all the two essential points of coolness and economy of fuel have been well secured.

Miscellaneous exhibits.

The following objects of interest are exhibited by England in Class 66:—Model of floating dock for ships of 4,800 tons, bought by France and sent to Saigon, in China, 300 ft. long, 94 ft. broad, and 27 ft. deep, by Randolph. Iron floating-dock for ships of 10,000 tons; dimensions, 432 ft. long, 110 ft. broad, and 53 ft. deep. One in operation at Bermuda. Patent fuel economiser for using the waste heat from steam-boiler, a saving of 25 per cent. of fuel, by Edward Green and Son, Manchester. Lenses for light-ships, by Wilkins, London. Side-lights for ships used by the Trinity steamers, economical and of great power, having dioptric lenses in lieu of bull's-eyes, by Wilkins. Model of Sunderland harbour

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and docks, Thomas Meek, Esq., engineer, showing the harbours and basins of Sunderland, with their various entrances, &c. Life-raft built in 1850 (presented by Captain F. B. Williams), by Richardson. Life-raft forming a portion of the waist of a ship, and therefore taking up no room for carriage. It is detached instantaneously, leaving an open space for the crew to escape. The raft carries a sail and compartments for food and water, and is very simple and buoyant, by Hurst. Models of ships, by Laird Brothers, of Birkenhead, beautifully executed. Some fine models of ships by Samuda Brothers. Models of ships by Randolph, of Glasgow. Models of engines by Humphreys of London.

A New Steering Compass (5) by John Lilly and Son, of London, entirely differs from others, as the needles only are placed in a vessel containing liquid which will not freeze at ordinary temperatures, and the indicating card is placed on the upper part of the compass bowl, thus avoiding any discolouration from the action of the spirit. It is fitted with a simple lifting apparatus, so that when not in use the needles and card can be raised from the point and thus very much preserved; and it is so constructed that it is perfectly steady in bad weather and exceedingly sensitive in smooth water.

A screw Propeller for shallow water, the flanges or blades having the action of a man's arms and hands in swimming. It is ingenious, and the experiments made with it give reason to believe that, if perfected, the invention may prove extremely valuable for the navigation of shallow rivers. Invented by Peter Nolan, of 51, Newman Street, Oxford Street.

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